ADEQ 1999 Annual Report List

The Arizona Department of Environmental Quality *1999 Annual Report* and its five appendices comprise the agency submittal to the Arizona State Legislature and the Governor's Office. The volume entitled *1999 Annual Report* is designed to serve the needs of our diverse customers by presenting an overview of the department's FY1999 activities. A list of all of the 1999 annual report documents is shown below. Statutory references for mandated reports are shown in parentheses where appropriate.

*1999 **Annual Report*** (A.R.S.§ 49-104.A.6)

Air Quality Report (A.R.S.§ 49-424.10), *Appendix I*

Recycling Report (A.R.S.§ 49-832.C), Waste Programs Division, *Appendix II*

Waste Programs Report, *Appendix III*

- Underground Storage Tank Assurance Fund Report (A.R.S.§ 49-1051.D)
- Waste Tire Report (A.R.S.§ 44-1306.B)
- WQARF Report (A.R.S.§ 49-282.G)
- Pollution Prevention Report (A.R.S.§ 49-966)
- Hazardous Waste Inspections and Enforcement Report (A.R.S.§ 49-105)

Groundwater Quality Report (A.R.S.§ 49-225.D), Water Quality Division, *Appendix IV*

Water Quality Report, *Appendix V*

- Water Quality Enforcement Report (A.R.S.§ 49-105)
- Aquifer Protection Permit Fee Schedule (A.R.S.§ 49-241.E)
- Aquifer Protection Permit Priority List (A.R.S.§ 49-241.D)
- Aquifer Protection Application Status (A.R.S.§ 49-241.E)
- 1999 Pesticide Annual Report (A.R.S.§ 49-303.B)

To obtain a free copy of the *1999 Annual Report* visit our website at: *www.adeq.state.az.us* or you can pick one up in person at ADEQ's Information Desk located at 3033 North Central Avenue, Phoenix, Arizona. You may also call (602) 207-2202 or in Arizona, (800)234-5677, extension 2202, to request a copy. If you are interested in purchasing one or more of the appendices, please call the number above for pricing information and ordering assistance.

1998 Air Quality Report

(A.R.S. §49-424.10)

Air quality monitoring by ADEQ, county agencies and private concerns is done for a variety of purposes. Historically, ADEQ efforts have emphasized determining compliance with federal and state health standards. These "criteria pollutant" monitors have been located in potential problem areas, and, in some cases, have resulted in the need to develop control plans to improve conditions.

Starting with the Phoenix and Tucson urban haze *(brown cloud)* studies in the early 1990s, ADEQ monitoring efforts have expanded to include visibility related measurements in National Parks and Wilderness Areas where visibility protection is required by the Clean Air Act.

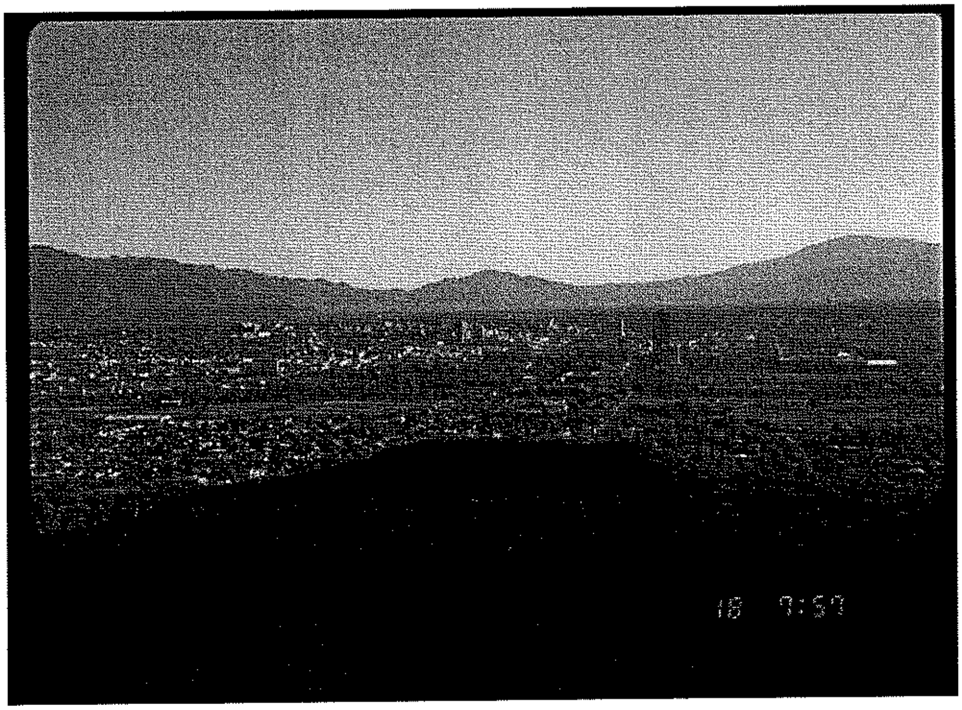
Special monitoring studies usually lasting one year or less are conducted from time to time, triggered by State legislative mandates or federal requirements.

The information in this report is of interest to a wide audience, including air quality professionals and individuals interested in air quality at a particular location or in comparing air quality around the State. The data reported are presented in a tabular format with critical information about each monitoring site, including location and pollutant concentrations arranged for comparison between sites and with the applicable standards.

Air quality trends at most of the long term monitors reveal improved air quality. Concentrations of carbon monoxide, lead, ozone and sulfur dioxide have improved dramatically since measurements began in the 1970s and all monitors have shown compliance with the health standards in recent years. Shorter periods of records for visibility in the urban and National Parks/Wilderness Areas make definitive trend assessments impossible at this time; however, in future annual reports, data interpretations will be presented for these areas. •

Arizona Department of Environmental Quality

1998 Air Quality Data for Arizona



A Clean Winter Morning View of the Tucson Metropolitan Area
from the University of Arizona Desert Laboratory at Tumamoc Hill

Prepared by the

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Acknowledgments

Numerous agencies, companies, individuals, and organizations have collected the ambient air quality monitoring data presented in this report. Arizona Department of Environmental Quality (ADEQ) publishes data from these various sources to provide as complete a picture as possible of air quality conditions throughout Arizona, and gratefully acknowledges the efforts of all involved. Generally, ambient data presented in this report are collected, processed, and reported following U.S. Environmental Protection Agency *(EPA)* policies and procedures. Air quality data collected by ADEQ staff and contract operators have also received internal and external quality control and assurance checks. Data provided by other sources have been checked by the responsible organization, but not by ADEQ.

Both private individuals and companies under contract to ADEQ provided invaluable field sampler operation and data processing services in support of monitoring activities during 1998. Their efforts are appreciated, as they maneuver on rooftops and metal towers to operate ADEQ monitoring equipment in uncomfortable weather conditions, or review instrument performance and ambient monitoring data for technical veracity. Field staff from other public agencies also operate numerous ambient monitoring sites in Arizona, providing spatial resolution and temporal coverage of air quality conditions statewide. ADEQ recognizes the efforts of these other monitoring and reporting agencies, and appreciates the opportunity to publish their data. Several industrial facilities collect and report ambient air quality data to ADEQ, usually to satisfy an operating permit requirement; their efforts are also acknow-ledged. Finally, ADEQ staff work daily; installing, calibrating, maintaining, conducting quality control checks, collecting, processing, performing quality assurance tests, and reporting data from a wide variety of ambient air monitoring instruments. ADEQ management wishes to thank these staff for their dedication to maintaining and improving the quality of our program. ●

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Part IV *(cont'd)*

List of Tables

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Introduction

This report presents the results of air quality monitoring conducted in 1998 throughout Arizona. Data from more than one hundred monitoring sites are reported, many of which have measurements of more than one pollutant. A majority of the air quality measurements are for traditional pollutants *(ozone, particulate matter, sulfur dioxide, carbon monoxide, nitrogen dioxide, lead)* with National Ambient Air Quality Standards *(NAAQS)*. Meteorological measurements, typically wind, are made at many of the sites. Visibility-related measurements are an increasing part of air monitoring activities in Arizona.

This year's report differs in format and content from previous annual air quality reports. The data tables contain only summaries of measurements arranged by pollutant to facilitate comparisons between monitoring sites and with applicable standards. Separate tables display compliance status for pollutants with multi year standards. Narrative text describes each pollutant's physical properties, measurement methods, form of the standards, and health and welfare effects. Photographs of monitoring sites are another new feature in this year's report.

Visibility data are presented in this year's report for the first time. The Arizona Department of Environmental Quality *(ADEQ)* began visibility monitoring in 1989 with the Phoenix Urban Haze *(Brown Cloud)* Study, which was followed by a similar study in Tucson. After completion of the intensive studies, scaled-down visibility networks have been operated in both cities. More recently we have begun development of a network of visibility-related sampling sites in National Parks and Wilderness areas where visibility protection is required by the Clean Air Act. These samplers complement the federal network and are the initial step toward Arizona's implementation of the national visibility program.

In addition to the ADEQ monitoring network, Maricopa, Pima and Pinal County air quality agencies also operated networks, as did several industrial facilities. All of their data are summarized in this report.

Part I of the report discusses the various air monitoring networks in Arizona with regards to their purpose, measurement methods, and the specific scale of geographic resolution of each network.

In **Part II**, data for each of the traditional pollutants are shown in tables. The accompanying text discusses the characteristics of each pollutant — its sources, effects, variability, and controls to reduce concentrations. Compliance with the NAAQS are discussed and shown in compliance tables in cases where more than one year of data is used for compliance determination.

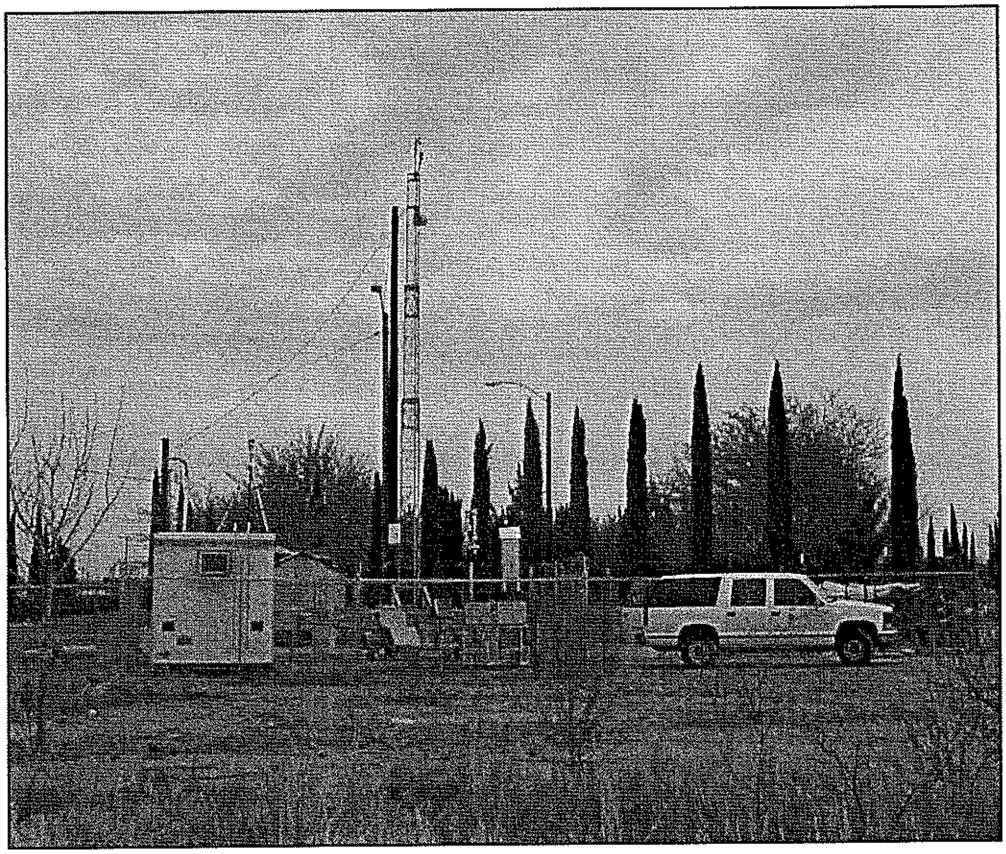
Part III presents activities from special monitoring projects such as visibility in Parks Wilderness and urban areas. Monitoring activities from the Mexican border studies in the Nogales and Douglas, Arizona areas are discussed along with supporting meteorological data used to interpret air quality concentration data.

Air quality trends are reported in **Part IV**. Air quality trends at most of the long-term monitors reveal improved air quality. Concentrations of carbon monoxide, lead, and sulfur dioxide have dramatically improved since measurements began in the 1970s, and all monitors for these pollutants have shown compliance with their health standards in recent years. Particulate matter *(PM_{10})* concentrations have also improved in rural and industrial areas where controls have been implemented, while less dramatic improvements have occurred in Phoenix and Tucson. Ozone concentrations have been fairly steady in Phoenix, Tucson, and Yuma where routine measurements have been made. Phoenix is the only area where violations of the ozone standard have been recorded, although concentrations have fallen significantly in recent years, and no exceedances have been recorded in 1997 and 1998. Shorter periods of records for visibility in the urban and National Parks/Wilderness Areas make trend assessments less definitive; nonetheless, trend assessments are shown for the two urban areas.

Future air quality annual reports are likely to have a new look. The Air Quality Division is constructing an automated data acquisition and storage system for air monitoring measurements. This will facilitate data analysis and graphics for future reports. A new three-level quality assurance/quality control process is also being implemented in 1999 with the automated system. These methods will be described in next year's report, and will improve the quality of the reported data.

Next year's reports will include data from the new $PM_{2.5}$ network and from the Douglas/Agua Prieta border study, both of which officially started in 1999. An EPA funded program known as the Photochemical Assessment Monitoring Stations *(PAMS)* that measures ozone precursors *(volatile organic compound gases)* began during the 1999 summer ozone season at one location in Phoenix with an additional site planned for 2000. Details of this program will also be included in next year's report. ●

Part I
Air Quality Monitoring Networks



Calvary Cemetery, Douglas

Part I - Ambient Air Quality Monitoring Networks

INTRODUCTION

As established by Congress in 1970, the federal Clean Air Act required the U.S. Environmental Protection Agency *(EPA)* to assist states and localities in establishing ambient air quality monitoring networks to characterize human health exposure and public welfare effects of criteria pollutants. The 1977 federal Clean Air Act Amendments required each state to implement a visibility monitoring network to cover specified national parks and wilderness areas. The Phoenix and Tucson metropolitan areas also have year-round visibility monitoring networks to assess urban hazes, following on detailed short-term studies conducted on behalf of Arizona Department of Environmental Quality *(ADEQ)* in the early 1990s. These networks are comprised of individual monitoring sites, and are operated to collect ambient air quality data to ensure that citizens of Arizona are able to know local air quality conditions, and to identify the causes of polluted air.

CRITERIA POLLUTANT MONITORING NETWORKS

The criteria pollutants are presently defined as sulfur dioxide *(SO_2)*, total particulate lead *(Pb)*, suspended particulate matter *(PM)*, ozone *(O_3)*, nitrogen dioxide *(NO_2)*, and carbon monoxide *(CO)*. These pollutants are monitored with Federal Reference or Equivalent Methods, certified by EPA. Particulate Matter monitoring was redefined by EPA in 1987 to measure particles less than or equal to 10 microns in aerodynamic diameter *(PM_{10})*, and again in 1997 to measure both PM_{10} and, separately, particles less than or equal to 2.5 microns in aerodynamic diameter *($PM_{2.5}$)*. Networks operated to monitor the nature and causes of visibility impairment utilize some of the same sampling methods and are described in more detail later in this section. Ambient monitoring networks for air quality are established to sample pollution in a variety of representative settings, to assess the health and welfare impacts, and to assist in determining the sources of air pollution. These networks cover both urban areas and rural areas of the state. These sampling networks are designed to satisfy monitoring objectives and measurement scales defined in **Tables I-1** and **I-2**.

Table I-1
Monitoring Objectives for Air Quality Monitoring Sites

Monitoring Objectives
1) Determine highest concentrations expected to occur in the area covered by the network.
2) Determine representative concentrations in areas of high population density.
3) Determine the impact on ambient pollution levels of significant sources or source categories.
4) Determine general background concentration levels.
5) Determine the extent of regional pollutant transport among populated areas; and in support of secondary standards.
6) Determine the welfare-related impact in more rural and remote areas *(such as visibility impairment and vegetation effects)*.

Table I-2
Measurement Scales for Air Quality Monitoring Sites

Pollutant	Carbon Monoxide	Sulfur Dioxide	Ozone	Nitrogen Dioxide	Lead	Particulate Matter
Measurement Scales *(represents concentrations in air volumes within areas defined below)*						
Micro Scale (0 to 100 meters)	X				X	X
Middle Scale (~100 to 500 meters)	X	X	X	X	X	X
Neighborhood Scale (~0.5 to 4 kilometers)	X	X	X	X	X	X
Urban Scale (~4 to 50 kilometers)		X	X	X	X	X
Regional Scale (~10 to 100s of kilometers)		X	X		X	X

For each criteria pollutant, EPA specifies monitoring objectives that define the parameters over which the health exposure and public welfare are assessed, and measurement scale classifications that describe the influence of atmospheric movement at that location.

The types and scales of monitoring sites described above are combined into networks, operated by a number of government agencies and regulated companies. These networks are comprised of one or more monitoring sites, whose data are compared to the National Ambient Air Quality Standards (*NAAQS*), as well as being statistically analyzed in a variety of ways. The agency or company operating a monitoring network also tracks data recovery, quality control, and quality assurance parameters for the instruments operated at their various sites. The agency or company often also measures meteorological variables at the monitoring site.

Finally, special continuous monitoring for the optical characteristics of the atmosphere, and manual sampling of ozone-forming compounds and other hazardous air pollutants is done by some of the agencies. The Maricopa, Pima, and Pinal Counties' networks are operated primarily to monitor urban-related air pollution. In contrast, the industrial networks are operated to determine the effects of their emissions on local air quality. The National Park Service network tracks conditions in and around national parks and monuments. The State network monitors a wide variety of pollutant and atmospheric characteristics, including urban, industrial, rural and background surveillance.

A list of the monitoring networks and their characteristics are shown in **Table I-3**. A list of individual sites and monitoring parameters, based on the best available information at the time of publication is presented in Appendix A.

Table I-3
Monitoring Networks Operating in Arizona

Network Operator	Geographic Area Monitored	Monitoring Objective(s) Covered (from above list)	Measurement Scale(s) Covered (from above list)	Pollutant(s) Monitored (from above list)
Arizona Department of Environmental Quality	Statewide	1,2,3,4,5,6	Micro, Middle, Neighborhood, Urban, & Regional	SO_2, Pb, O_3, NO_2, CO, PM_{10}, & $PM_{2.5}$
Arizona Portland Cement Company	Rillito	1,3	Neighborhood	PM_{10}
Arizona Public Service Company	Joseph City	1,3	Middle	PM_{10}
ASARCO, Inc.	Hayden	1,2,3	Middle & Neighborhood	SO_2
BHP Copper, Inc.	San Manuel	1,2,3	Middle & Neighborhood	SO_2
Cyprus Miami Mining Corporation	Miami	1,2,3	Neighborhood	SO_2, PM_{10}, & $PM_{2.5}$
Maricopa County Environmental Services Department	Phoenix Urban Area & Maricopa County	1,2,3,4,5,6	Micro, Middle, Neighborhood, Urban, & Regional	SO_2, Pb, O_3, NO_2, CO, & PM_{10}
National Park Service	National Parks & Monuments	3,4,5,6	Urban & Regional	SO_2, O_3, NO_2, PM_{10}, & $PM_{2.5}$
Phoenix Cement Company	Clarkdale	1,3	Neighborhood	PM_{10}, $PM_{2.5}$, & Lead
Pima County Department of Environmental Quality	Tucson Urban Area & Pima County	1,2,3,4,5,6	Micro, Middle, Neighborhood, Urban, & Regional	SO_2, Pb, O_3, NO_2, CO, PM_{10}, & $PM_{2.5}$
Pinal County Air Quality Control District	Pinal County & Phoenix Urban Area	1,2,3,4,5	Middle, Neighborhood, Urban, & Regional	O_3, CO, PM_{10}, & $PM_{2.5}$
Praxair, Inc.	Kingman	1,3	Middle	PM_{10}
Salt River Project	Page & St. Johns	1,3	Urban & Regional	NO_2, O_3, SO_2, PM_{10}, & $PM_{2.5}$
Southern California Edison Company	Bullhead City, AZ & Laughlin, NV	1,2,3,4	Neighborhood, Urban, & Regional	SO_2, NO_2, & PM_{10}
Tucson Electric Power Company	Tucson & Springerville	1,2,3	Middle & Regional	SO_2, NO_2, PM_{10}, & $PM_{2.5}$

Visibility Monitoring Networks in National Parks and Wilderness Areas

Visibility monitoring networks track impairment in specified national parks and wilderness areas. These parks and wilderness areas are called Class I Areas, where air quality is to be restored to natural background levels, and were designated based on an evaluation required by Congress in the 1977 federal Clean Air Act Amendments. The evaluation, which was performed by the U.S. Forest Service *(USFS)* and National Park Service *(NPS)*, reviewed the wilderness areas of parks and national forests that were designated as wilderness before 1977, were more than 6,000 acres in size, and have visual air quality as an important resource for visitors. Of the 156 Class I Areas designated across the nation, 12 are located in Arizona; the air quality programs associated with these areas are described in more detail in **Part III** of this report.

From the Class I Area designations in 1980, EPA then initiated a nationally-operated monitoring network in 1987, called the Interagency Monitoring of PROtected Visual Environments *(IMPROVE)* program. The purpose of the IMPROVE network is to characterize broad regional trends and visibility conditions using monitoring data collected at approximately 30 Class I Areas across the United States. The IMPROVE visibility monitoring network consists of four NPS sites in Arizona, at Grand Canyon National Park, Petrified Forest National Park, Tonto National Monument, and Chiricahua National Monument. Beginning in 1996, ADEQ has developed a separate Class I monitoring network directed at obtaining visibility monitoring data for each Arizona Class I Area, in partnership with the locally-based federal officials of the NPS and USFS responsible for protecting air quality in a specific Class I Area. The intent of the ADEQ program is to collect visibility data at or near all of the eight remaining Class I Areas in Arizona not covered by the IMPROVE network. To date, ADEQ has installed visibility monitoring sites in the West Unit of Saguaro National Park, and in or near the USFS Chiricahua, Galiuro, Sycamore Canyon, Mazatzal, and Sierra Ancha Wilderness Areas.

Urban Haze Networks

Detailed studies of the nature and causes of urban hazes were conducted by contractors on behalf of ADEQ in the Phoenix area during the winter of 1989-90 and in the Tucson area during the winter of 1992-93. Each of those studies recommended long-term, year-round monitoring of visibility, and ADEQ then made a commitment to doing so with instrument deployment starting in 1993. Visibility monitoring data from the Tucson and Phoenix long-term urban haze networks are needed to:

- Provide policy-makers and the public with information.
- Track short-term and long-term trends.
- Assess source contributions to urban haze.
- Better evaluate the effectiveness of air pollution control strategies.

Because the urban haze networks conduct routine special filter sampling of particulate matter composition and variation, the data from PM_{10} and $PM_{2.5}$ samplers operated in the urban haze networks enhance other, related air quality databases by:

- Maintaining a greater density of particulate matter sampling sites, and expanding the coverage of existing county air pollution control agency networks into perimeter areas of urban growth;

- Measuring the diurnal variation and chemical composition of particulate matter on a year-round basis.
- Obtaining comparable PM_{10} and $PM_{2.5}$ concentration data by standardizing the PM_{10} and $PM_{2.5}$ instrument types used throughout the State.

The Phoenix and Tucson metropolitan area networks are similar as well as to the scope and scale of the networks operated by ADEQ contractors in the Phoenix and Tucson special studies. Some of these sites are existing air pollution monitoring locations, while other, new sites have been selected and installed. The networks include $PM_{2.5}$ Federal Reference Method sampling sites that began operation in January 1999. A complete summary of the operations of the urban haze networks can be obtained from ADEQ by requesting a copy of the document entitled "Phoenix & Tucson Long-Term Urban Haze and Particulate Matter Monitoring Plan."

Monitoring Methods

The gaseous criteria pollutants, SO_2, O_3, NO_2, and CO, are monitored with continuous analyzers taking approximately one pollutant sample per second. These values are then averaged on an hourly basis, and recorded to the correct number of significant digits, based on the form of the NAAQS and the detection limits of the instrument. In most cases, the hourly data are summarized into the appropriate multi-hour averages. The analyzers are certified as Federal Reference or Equivalent Methods, meaning that EPA has tested and certified a particular model manufactured by an instrument maker. Regular checks of the stability, reproducibility, precision, and accuracy of these instruments are conducted by either the agency or company network operators. Precision and accuracy of ambient data are assessed across an entire network, using statistical tests required by EPA.

Particulate lead (Pb), and suspended particulate matter (PM_{10} and $PM_{2.5}$), are usually sampled for 24 hours, from midnight to midnight, most often every-sixth-day. Ambient air is drawn through an inlet of a specified design, at a known flow rate, using a calibrated timer, onto a filter that collects all PM less than a diameter specified by the inlet design. Lead, PM_{10}, and $PM_{2.5}$ samples are processed in the same manner; those filters are weighed before and after the sample period to determine the difference in mass, and then integrated with flow rate and timer data to arrive at a mass per unit volume concentration. In the case of Pb, the filter is then subjected to chemical analysis to determine the amount of Pb particulate, and integrated with the flow rate and timer information to calculate the concentration. These data are then summarized into the appropriate quarterly or annual averages. These samplers are also certified as Federal Reference or Equivalent Methods. Regular checks of the stability, reproducibility, precision, and accuracy of the samplers and laboratory procedures are conducted by either the agency or company network operators. Again, precision and accuracy of ambient data are assessed across an entire network, using statistical tests required by EPA.

Visibility monitoring methods are generally divided into three groups: aerosol (PM), optical, and scene. Monitoring of visibility requires qualitative and quantitative information about the causes of haze *(what is in the air, e.g., the formation, transport and deposition of pollutants)*, and the nature of haze *(what are the optical effects of those pollutants to the observer)*. The preferred system for recording scene conditions of visual air quality associated with hazes is a color video camera, which utilizes a Super-VHS format, and is programmed to advance at the rate of one frame every four minutes during daylight hours. The video recording system is set to start just before sunrise, and to stop just after sunset, for each day. Scene information can also be obtained from 35 millimeter slides, taken at the same times each day, to establish baseline conditions, and track variation in haze.

Quantitative measurement of light extinction (B_{ext}) has four components:

- Light scattering by gases (B_{sg}),
- Light absorption by gases (B_{ag}),
- Light scattering by particles (B_{sp}), and
- Light absorption by particles (B_{ap}).

Mathematically, the relationship is expressed as follows:

$$B_{ext} = B_{sg} + B_{ag} + B_{sp} + B_{ap}$$

where the units are inverse megameters *(Mm^{-1})*, or the amount of light removed per million meters of distance a viewer looks through.

Total optical light extinction *(B_{ext})* is measured directly with a device called a transmissometer. The transmissometer generates visible light in the same wavelength *(550 nanometers)* as the human eye detects and then transmits that light beam over a sight path of several kilometers to a photocell detector. The transmissometer's design and operation allow its data to be directly correlated with human perception of visibility through the atmosphere. Transmissometer data are also used to check the general accuracy of the sum of the components of light extinction as measured by other continuous monitors. Due to the expense of purchasing, installing, and maintaining these systems, a single, representative sight path is monitored in each urban area, and three of the Class I Areas. These measurements began on a routine basis during 1993 in both of the urban areas.

Light scattering by gases *(B_{sg})* is a function of air density and is unrelated to air pollution sources. This parameter is derived and does not require measurement. In contrast, the other three components of light extinction are human-caused, and require measurement with continuous monitors. Light absorption by gases *(B_{ag})* is determined by continuously measuring nitrogen dioxide *(NO_2)*, since it is the only gas normally present in urban or Class I Areas that absorbs significant quantities of visible light. Several EPA Reference or Equivalent Method NO_2 monitors are deployed to verify maintenance of the NAAQS throughout the Tucson and Phoenix metropolitan areas, while the National Park Service network tracks NO_2 at several national parks in Arizona.

Light scattering by particles *(B_{sp})* is determined by continuously, directly measuring particle scattering variation in a calibrated ambient sampling chamber called a nephelometer. The nephelometer samples air at ambient temperature and relative humidity conditions. Routine monitoring with this instrument began in both the Class I Area and urban haze networks during 1996. Light absorption by particles *(B_{ap})* is determined by continuously measuring the quantity of light transmitted through a filter tape, or intermittently through a filter from a PM sampler. Data from these analyses are reported in micrograms per cubic meter *($\mu g/m^3$)* of elemental carbon, and are converted to the B_{ap} units of Mm^{-1} using a laboratory-derived light absorption coefficient. Routine data collection using a continuous instrument, the aethalometer, began in

December 1996 in Phoenix, and February 1998 in Tucson. B_{ap} is also measured intermittently using the PM sample filters collected in both the Class I Area and urban haze networks.

In monitoring visibility it is also essential to collect and analyze particulate samples, to define and understand the chemistry of aerosols present before, during, and after haze events. The chemical speciation data can be used to determine the contributions of each source category to the observed optical haze data. From these filter data, the chemical components are used to calculate light extinction for the filter sample period and compared with continuous measurements as a check. Finally, the samplers used in the urban haze networks also monitor compliance with PM_{10} and $PM_{2.5}$ air quality standards, and provide information on the categorical source contributions to observed PM_{10} and $PM_{2.5}$ concentrations.

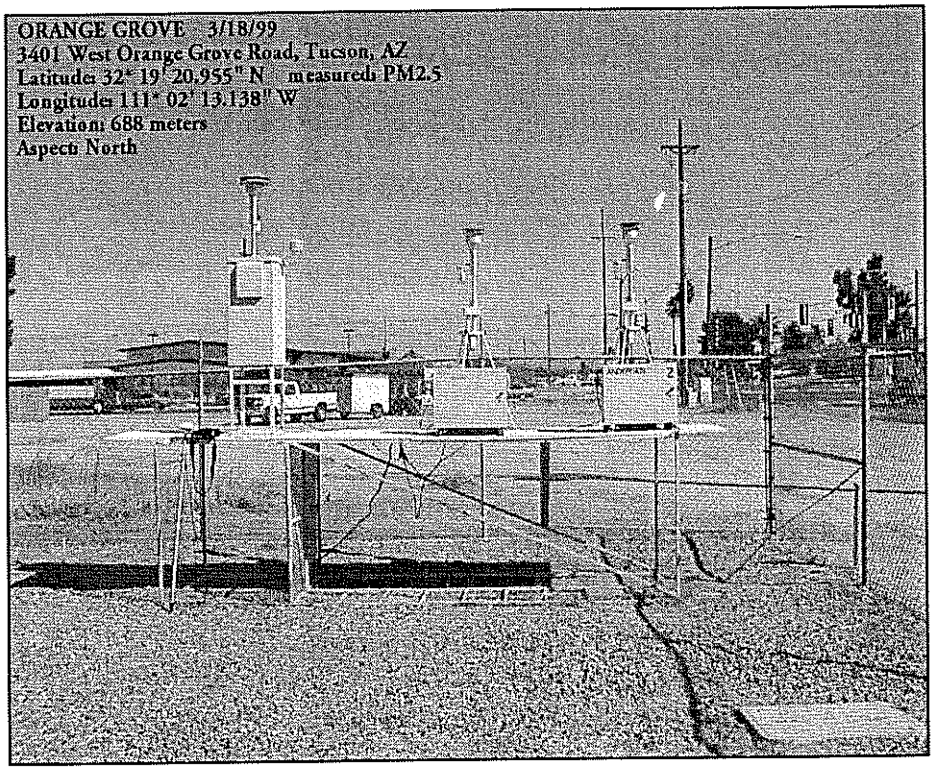
Routine PM sampling for visibility began throughout the Tucson urban area in July 1993, and was phased in across the Phoenix urban area between October 1994 and February 1995. Class I Area monitoring of PM for visibility analyses began in 1987 in the IMPROVE network, and in 1996 for the ADEQ Class I Area network. Sampling frequency for PM in the urban networks is generally every-sixth-day, and every Wednesday and Saturday in the ADEQ and IMPROVE Class I Area networks. Every-day sampling at all monitoring sites is cost-prohibitive and very personnel-intensive with current particulate sampling technologies. Targeted, more frequent sampling at specified sites, either as routine sampling and/or as season-specific sampling, is occasionally done to support special studies. The implementation of such targeted, site-specific sampling is generally determined from criteria based on meteorological forecasts of atmospheric conditions, and considers the characteristics of sources causing haze to form.

Finally, too more fully understand the causes of hazes often associated with certain atmospheric conditions, it is necessary to monitor certain meteorological parameters. In the Phoenix area, routine measurements of upper air temperature and water vapor are not made, and Tucson National Weather Service observations are confined to twice-daily rawinsonde launches. For these reasons, each network includes three sites recording temperature/relative humidity data. These sites record at three elevations above ground level *(agl)*:

1. The Central (Urban Center) Site, about 3 meters agl.
2. The transmissometer receiver site as a mid-level site, about 30 meters agl.
3. An upper-level site, 100 to 300 meters agl.

These static sites are designed to represent the free atmosphere, and the data obtained from them is assessed to eliminate contamination by building wakes, surface heating, et cetera. In contrast, wind speed and direction monitoring sites are not included in these networks, as adequate ground-based networks to characterize these parameters are already in operation. In the Class I Area networks, temperature, wind variables, and relative humidity are measured at all optical monitoring sites. ●

PART II
CRITERIA POLLUTANTS



Urban Visibility and Particulate Matter Monitoring Site
Orange Grove Road, Tucson

ERRATA

1999 ANNUAL REPORT - APPENDIX I
AIR QUALITY DIVISION

Table II-4 , Page II-10

Values in the Maximum 24-HR Average column should be changed for the Hayden-Old Jail and Miami-Ridgeline sites:

Hayden - Old Jail	Old value=485	New value=122
Miami - Ridgeline	Old Value=165	New value= 40

Note: this changes the 1998 SO2 Exceedances by County box at the top of the page: Gila 24-hr exceedance total should be changed from 1 to 0

Table II-4
1998 Sulfur Dioxide Data (in ug/m^3)

Standards:
Annual Average must not exceed 80 ug/m^3 (0.03 ppm) with 75% data recovery
2nd highest 3-hour Average must be less than 1300 ug/m^3 (0.50 ppm) 2nd highest 24-hour Average must be less than 365 ug/m^3 (0.14 ppm)

Note: Arizona Standards reported in ug/m^3 and Federal Standards reported in ppm

1998 SO2 Exceedances by County:	Ann.	3-hr	24-hr
Apache	0	0	0
Coconino	0	0	0
Gila	0	0	0
Maricopa	0	0	0
Mohave	0	0	0
Pima	0	0	0
Pinal	0	0	0

SUMMARY: 23 of 23 monitors in compliance

COUNTY AND CITY OR SITE	ANNUAL AVERAGE	MAXIMUM 3-HR AVERAGE	MAXIMUM 24-HR AVERAGE	NUMBER OF SAMPLES
APACHE:				
St. Johns - Mesa Parada	5	72	14	8036
Springerville - Coyote Hills	< 1	102	29	7884
Springerville - Airport	< 1	47	11	7884
Springerville - 15 mi NE	5	123	37	7796
COCONINO:				
Page	4	71	24	8666
GILA:				
Hayden - Garfield Ave.	20	770	237	8395
Hayden - Old Jail	13	647	110	8392
Hayden - Junction	9	368	65	8372
Hayden - Montgomery Ranch	41	768	186	8325
Hayden - Old Jail	29	595	122	7457
Miami - Ridgeline	8	175	40	8264
Miami - Jones Ranch	10	840	123	8738
Miami - Town Site	2	210	28	8739
Winkleman	32	1284	178	8377
MARICOPA :				
Central Phoenix	8	63	31	7339
South Scottsdale	3	31	16	7291
MOHAVE:				
Bullhead City - Alonas Way	4	123	45	8642

PART II - CRITERIA POLLUTANTS

INTRODUCTION

The U. S. Environmental Protection Agency has established National Ambient Air Quality Standards *(NAAQS)* for several common air pollutants: carbon monoxide, ozone, nitrogen dioxide, sulfur dioxide, lead, particulate matter 10 microns *(PM_{10})* and smaller, and particulate matter 2.5 microns *($PM_{2.5}$)* and smaller. These pollutants are monitored in Arizona by industry, by county air pollution districts, by Indian tribes, and by the Arizona Department of Environmental Quality *(ADEQ)*. This section of the report presents basic information about each of these pollutants and their 1998 measurements.

CARBON MONOXIDE

Carbon monoxide — a colorless, odorless, tasteless gas that is produced in the incomplete combustion of fuels — has a variety of adverse health effects that arise from its chemically binding with blood hemoglobin. Carbon monoxide successfully competes with oxygen for binding with hemoglobin and thereby impairs oxygen transport. This impaired transport leads to several central nervous system effects, such as the impairment of time interval discrimination, changes in relative brightness thresholds, increased reaction time, and headache, fatigue, and dizziness. Carbon monoxide exposures also contribute to or exacerbate arteriosclerotic heart disease.

About 75 percent of carbon monoxide emissions come from on-road motor vehicles, 20 percent from off-road vehicles or equipment such as construction vehicles and lawn and garden equipment, and 5 percent from fuel combustion from commercial and residential heating. This pollutant has low background levels, has its highest concentrations next to the busiest streets, and has elevated neighborhood concentrations in locations that reflect emissions transported from upwind portions of the city. Its concentrations peak in November - January, because its emissions are highest in cold weather — automotive emissions of carbon monoxide vary inversely with temperature — and because the surface layer of the atmosphere is at its most stable. Hourly concentrations tend to be at their maximum between 6 p.m. and 12 midnight, and during the morning rush hour.

Controls have reduced carbon monoxide emissions to the point where the standards have been achieved in greater Phoenix in 1996 - 1998, in stark contrast to the first half of the 1980s, when over 100 exceedances were recorded each year. Similar improvements have occurred in Tucson, where the last exceedance was recorded in 1984. Of these controls, equipping vehicles with catalytic converters and electronic ignition systems were the most effective, but significant reductions can also be attributed to the Vehicle Inspection and Maintenance Program *(beginning in 1976)* and oxygenated fuels *(beginning in 1989)*.

Carbon monoxide is monitored continuously with non-dispersive infrared instruments that are deployed in urban neighborhoods and near busy roadways or intersections. Sixteen monitors were operated in greater Phoenix, four in Tucson, and one in Casa Grande in 1998. The National Ambient Air Quality Standards for carbon monoxide, not to be exceeded more than once a year, are 35 ppm for a one-hour average and 9 ppm for an eight-hour average. Neither standard was violated in Arizona in 1998. **Table II-1** presents the 1998 carbon monoxide data in Arizona.

Table II-1
1998 Carbon Monoxide Data *(in ppm)*

Standards:
1-hour 35 ppm not to be exceeded more than once per year
8-hour 9 ppm not to be exceeded more than once per year

1998 CO Exceedances by County:	1-hr	8-hr
Maricopa	0	0
Pima	0	0
Pinal	0	0

SUMMARY: 21 of 21 monitors in compliance

COUNTY AND CITY OR SITE	1-HR AVERAGE MAX	1-HR AVERAGE 2ND HIGHEST	8-HR AVERAGE MAX	8-HR AVERAGE 2ND HIGHEST	NUMBER OF SAMPLES COLLECTED
MARICOPA:					
West Chandler	4.1	4.0	2.9	2.9	8394
Gilbert	3.5	3.3	2.7	2.7	8340
Glendale	5.0	4.9	3.4	3.3	7606
Mesa	6.5	6.1	4.4	4.3	8424
South Phoenix	8.2	7.9	5.4	5.4	8197
Central Phoenix	9.1	8.9	7.1	7.1	8173
North Phoenix	8.0	7.3	6.1	5.9	8193
Phoenix - West Indian School	9.7	9.4	8.1	8.1	8364
West Phoenix	10.7	9.6	7.7	7.7	8211
Phoenix Post Office	9.4	9.3	8.2	6.9	7450
Phoenix - Grand Avenue [a]	10.7	9.6	7.3	6.8	3757
Phoenix - JLG Super Site [a]	9.6	8.9	7.2	6.6	3512
Phoenix - Greenwood - MCESD	9.4	8.9	7.5	7.3	7547
Phoenix - Maryvale	7.5	7.5	6.1	6.1	8621
South Scottsdale	5.5	5.2	3.7	3.6	8127
PIMA:					
Tucson - Downtown	7.6	7.5	4.3	3.9	8496
Tucson - Craycroft	4.8	4.6	2.6	2.3	8489
Tucson - Alvernon	7.8	7.6	4.0	4.0	8739
Tucson - Cherry	5.9	5.1	4.3	3.1	7930
PINAL:					
Apache Junction Highway Yard	2.0	2.0	1.3	1.3	8609
Casa GrandeAirport	3.9	3.6	1.5	1.5	8513

Footnotes: a - Seasonal Monitor *(October through March)*

LEAD

Lead, a heavy metal with pronounced toxic effects, is present in the atmosphere as a constituent of fine particles. Chronic lead poisoning attacks the blood, the brain and nervous system, the kidney, and the reproductive system, with such effects as moderate to severe brain and kidney damage, sterility, and abortions, stillbirths, and neonatal deaths. Low-level chronic exposure to lead manifests itself first in the inhibition of the biosynthesis of hemoglobin, resulting in the anemia associated with chronic lead poisoning.

Emissions of lead in Arizona come from the smelting of ore, the combustion of fossil fuels, and, until the mid-1970s, from the use of alkyl lead compounds as anti-knock additives in gasoline. With the phasing out of regular lead gasoline, the automotive emissions of lead to the atmosphere have declined to near zero. Concentrations of lead in Arizona, in both urban and rural settings with the exception of Hayden, vary from 0.1 percent to 3.3 percent of the standard.

Controls to reduce lead emissions have been extremely effective, with a net 94 percent reduction on a national basis from 1978 to 1987: automotive emissions were reduced 97 percent through the elimination of lead compounds in gasoline; stationary source fuel combustion emissions were reduced 92 percent; and industrial processes and solid waste disposal emissions were reduced substantially as well.

Lead is monitored by analyzing PM_{10} samples collected for 24 hours, generally every sixth day. Total Suspended Particulate *(TSP)* samplers are the Reference Method, but are no longer used to obtain lead data. Lead is primarily a combustion product, so PM_{10} samples capture ambient lead concentrations adequately. Of the 17 sites where lead was determined in 1998, four are urban *(Phoenix, Payson, Douglas, and Nogales)*, three are located near either a smelter *(Hayden)* or cement plant *(Clarkdale)*, and nine are background sites. The National Ambient Air Quality Standard for lead — 1.5 micrograms per cubic meter *($\mu g/m^3$)*, averaged for a calendar quarter — was not exceeded at any Arizona monitors. **Table II-2** presents the lead data collected in Arizona in 1998 for all monitoring sites except the IMPROVE network.

TABLE II-2
1998 LEAD DATA IN PM_{10} *(IN UG/M^3)*

1998 Lead Exceedances by County:			
Cochise	0	Pima	0
Gila	1	Santa Cruz	0
Maricopa	0	Yavapai	0

SUMMARY: 11 of 12 monitors in compliance

Standard:
1.5 ug/m^3, maximum arithmetic mean averaged over a calendar quarter with 75 percent data recovery

COUNTY AND CITY OR SITE	QUARTERLY AVERAGE				NUMBER OF SAMPLES			
	1	2	3	4	1	2	3	4
COCHISE:								
Douglas - Red Cross [a]	-- [b]	-- [b]	.005	.008	-- [b]	-- [b]	4	14
GILA:								
Hayden	.210	.169	.468	.180	15	16	15	16
Payson	.003	.002	.002	.003	15	15	15	13
MARICOPA:								
Phoenix - Greenwood - ADEQ	-- [b]	-- [b]	.006	.018	-- [b]	6	15	16
Palo Verde	.023	.013	.016	.025	12	16	13	15
PIMA:								
Organ Pipe Cactus National Monument	.050	.003	.002	.004	14	12	16	14
SANTA CRUZ:								
Nogales	.009	.007	.005	.015	13	13	8	14
YAVAPAI:								
Clarkdale - NW Cement Plant	.004	.000	.000	.000	15	15	15	16
Clarkdale - SE of CTI Flyash Silo	.002	.000	.000	.000	15	15	15	16
Clarkdale - ADEQ	.002	.007	.002	.013	11	11	14	16
Hillside	.001	.001	.001	.001	12	12	12	10
Montezuma Castle National Monument	.010	.004	.002	.008	14	14	14	7

Footnotes: a - New Site b - Invalid average due to insufficient number of samples

NITROGEN DIOXIDE

Nitrogen dioxide *(NO_2)* is a reddish-brown gas that is formed by the oxidation of nitric oxide *(NO)*, which itself is a byproduct of combustion of all fuels. At the lowest nitrogen dioxide exposure levels at which adverse health effects have been detected, respiratory damage has been observed: destruction of cilia, alveolar tissue disruption, and obstruction of the respiratory bronchioles. Animal studies suggest that nitrogen dioxide may be a causal or aggravating agent in respiratory infections. Community exposure studies to lower ambient levels of nitrogen dioxide, however, have demonstrated no significant links with respiratory symptoms or disease. This pollutant is of greater concern in its reduction of visibility *(it causes 5 percent of the visibility reduction in Phoenix)* and in its contributory role in the photochemical formation of ozone.

Combustion emissions of nitrogen oxides are 95 percent nitric oxide and 5 percent nitrogen dioxide. Because nitric oxide is rapidly oxidized to nitrogen dioxide, nitric oxide emissions serve as a surrogate for nitrogen dioxide. In a recent Phoenix emissions inventory, the transportation sector dominated nitric oxide emissions: 58 percent of the emissions came from cars and trucks, 27 percent came from off-road vehicles such as trains and diesel-powered construction vehicles, and 15 percent from other sources, including power plants, biogenic emissions from soil, and stationary combustion sources. Nitric oxide and nitrogen dioxide concentrations are highest near major roadways. Nitric oxide concentrations decrease rapidly with distance from the roadway, whereas nitrogen dioxide concentrations are more evenly distributed because of their formation through oxidation and their subsequent transport. Concentrations of nitrogen dioxide are highest in the late afternoon and early evening of winter, when rush-hour emissions of nitric oxide are converted to nitrogen dioxide under relatively stable atmospheric conditions. Because nitric oxide reacts rapidly with ozone, nocturnal ozone concentrations in cities are often reduced to near-zero levels. This nitric oxide scavenging of ozone does not occur in remote areas. Nocturnal ozone concentrations at background sites are high compared with the urban concentrations.

Nitrogen oxides emissions from motor vehicles have been reduced through retardation of spark timing, lowering the compression ratio, exhaust gas recirculation systems, and three-way catalysts. The Vehicle Inspection and Maintenance Program, with its NOx test for light-duty gasoline vehicles 1981 and newer *(in Phoenix only)* and its opacity test for diesel vehicles, has also helped. Reformulated gasolines also decrease nitrogen oxides emissions: Federal Phase II gasoline, by 1.5 percent for vehicular and 0.5 percent for off-road equipment; California Phase 2 gasoline, by 6.4 percent for vehicular and 7.7 percent for off road equipment.

Nitrogen dioxide is monitored continuously with chemiluminescence instruments, which also determine nitric oxide concentrations and the sum of the two, NOx concentrations. These instruments are located in urban neighborhoods where either the emissions are dense or where ozone concentrations tend to be at their maximum. In addition, these monitors are located near major coal-fired electrical power plants. Fifteen monitors were operated in Arizona in 1998: six near power plants, eight urban, and one background. The National Ambient Air Quality Standard for nitrogen dioxide is 0.053 parts per million for an annual average. The nitrogen dioxide annual averages near power plants ranged from 2 percent to 34 percent of the standard; in the urban areas, 21 percent to 96 percent. **Table II-3** presents the nitrogen dioxide data collected in Arizona in 1998.

TABLE II-3
1998 NITROGEN DIOXIDE DATA *(IN PPM)*

1998 NO2 Exceedances by County:			
Apache	0	Mohave	0
Coconino	0	Pima	0
Maricopa	0		

SUMMARY: 15 of 15 monitors in compliance

Standard:
Annual average must not exceed .053 ppm
with 75 percent data recovery per quarter

COUNTY AND CITY OR SITE	ANNUAL AVERAGE	MAXIMUM 1-HR AVG	MAXIMUM 24-HR AVG	NUMBER OF SAMPLES
APACHE:				
St. Johns - Mesa Parada	.003	.036	.009	8034
Springerville - Airport	.001	.026	.006	7884
Springerville - Coyote Hills	.001	.038	.010	7796
Springerville - 15 mi NE	.003	.031	.010	7796
COCONINO:				
Page	.003	.052	.017	8671
MARICOPA:				
Palo Verde [a,c]	.001[b]	.038	.009	4596
Phoenix - JLG Super Site	.026	.145	.052	7664
Central Phoenix	.051	.097	.060	8790
Phoenix - Greenwood - MCESD	.034	.116	.074	8439
West Phoenix	.028	.110	.066	8463
South Scottsdale	.023	.088	.048	8787
Salt River - Pima [a,c]	.011[b]	.171	.084	3659
MOHAVE:				
Bullhead City - Alonas Way	.018	.066	.046	7177
PIMA:				
Tucson - Craycroft	.017	.059	.037	8613
Tucson - Children's Park [a]	.016[b]	.061	.036	5606

Footnotes: a - New Site b - Invalid annual average due to insufficient number of samples
c - Seasonal Monitor *(April through October)*

Sulfur Dioxide

Exposure to sulfur dioxide, a colorless gas with a pungent, irritating odor at elevated concentrations, alters the mechanical function of the upper airway, including increasing the nasal flow resistance and decreasing the nasal mucus flow rate. Short-term exposures result in an exaggerated air flow resistance in about 10 percent of the subjects tested, and produce acute bronchoconstriction in strenuously exercising asthmatics.

In Arizona the principal source of sulfur dioxide emissions has been the smelting of sulfide copper ore. Most fuels contain trace quantities of sulfur, and their combustion releases both gaseous sulfur dioxide (SO_2) and particulate sulfate (SO_4^{--}). A recent sulfate inventory for Phoenix has 32 percent of the emissions from point sources, 26 percent from area sources, 23 percent from off-road vehicles and equipment, and 19 percent from on-road motor vehicles. Sulfur dioxide is removed from the atmosphere through dry deposition on plants and its conversion to sulfuric acid and eventually to sulfate. Sulfur dioxide has extremely low background levels, with elevated concentrations found downwind of large point sources. Concentrations in urban areas are low and are homogeneously distributed, with annual averages varying from 3 to 11 $\mu g/m^3$.

Major controls were installed in Arizona's copper smelters in the 1980s, reducing sulfur dioxide emissions substantially. Vehicular emissions of sulfur dioxide and sulfate have been reduced through lowering the sulfur content in diesel fuel and gasoline.

Sulfur dioxide is monitored continuously with pulsed fluorescence instruments, most of which are clustered around copper smelters or coal-fired electric power plants. In 1998, fifteen monitors were sited near copper smelters, six near power plants, and five in urban areas. The National Ambient Air Quality Standards for sulfur dioxide are 1300 $\mu g/m^3$ for a three-hour average and 365 $\mu g/m^3$ for a 24-hour average, not to be exceeded more than once a year, and 80 $\mu g/m^3$ for the annual average. The maximum concentration sites — all near copper smelters — comply with these standards: the concentrations being no higher than 65 percent of the three-hour, 90 percent of the 24-hour, and 55 percent of the annual average standards. Sites near power plants are close to background levels, with annual averages from less than 1 to 8 $\mu g/m^3$. **Table II-4** presents the sulfur dioxide data collected in Arizona in 1998.

TABLE II-4
1998 SULFUR DIOXIDE DATA *(IN UG/M³)*

1998 SO2 Exceedances by County:	Ann.	3-hr	24-hr
Apache	0	0	0
Coconino	0	0	0
Gila	0	0	1
Maricopa	0	0	0
Mohave	0	0	0
Pima	0	0	0
Pinal	0	0	0

SUMMARY: 22 of 23 monitors in compliance

Standards:
Annual Average must not exceed 80 ug/m^3 *(0.03 ppm)* with 75 percent data recovery
2nd highest 3-hour Average must be less than 1300 ug/m^3 *(0.50 ppm)*
2nd highest 24-hour Average must be less than 365 ug/m^3 *(0.14 ppm)*

Note: Arizona Standards reported in ug/m^3 and Federal Standards reported in ppm

COUNTY AND CITY OR SITE	ANNUAL AVERAGE	MAXIMUM 3-HR AVERAGE	MAXIMUM 24-HR AVERAGE	NUMBER OF SAMPLES
APACHE:				
St. Johns - Mesa Parada	5	72	14	8036
Springerville - Coyote Hills	< 1	102	29	7884
Springerville - Airport	< 1	47	11	7884
Springerville - 15 mi NE	5	123	37	7796
COCONINO:				
Page	4	71	24	8666
GILA:				
Hayden - Garfield Ave.	20	770	237	8395
Hayden - Old Jail	13	647	110	8392
Hayden - Junction	9	368	65	8372
Hayden - Montgomery Ranch	41	768	186	8325
Hayden - Old Jail	29	595	485	7457
Miami - Ridgeline	8	175	165	8264
Miami - Jones Ranch	10	840	123	8738
Miami - Town Site	2	210	28	8739
Winkleman	32	1284	178	8377
MARICOPA :				
Central Phoenix	8	63	31	7339
South Scottsdale	3	31	16	7291

TABLE II-4 *(CONT'D)*
1998 SULFUR DIOXIDE DATA *(IN UG/M³)*

COUNTY AND CITY OR SITE	ANNUAL AVERAGE	MAXIMUM 3-HR AVERAGE	MAXIMUM 24-HR AVERAGE	NUMBER OF SAMPLES
MOHAVE:				
Bullhead City - Alonas Way	4	123	45	8642
PIMA:				
Green Valley *(Sierrita - Elam Ranch)*	3	136	21	8441
Tucson - Craycroft	5	42	13	8676
PINAL:				
San Manuel - Townsite	8	570	105	8656
San Manuel - Dorm Site	8	262	135	8714
San Manuel - LDS Church	8	707	102	8494
San Manuel - Hospital	11	712	154	8642

OZONE

Ozone — a colorless, slightly odorous gas — is both a natural component of the atmosphere, through its photochemical formation from natural sources of methane, carbon monoxide, hydrocarbons, and nitrogen oxides, and an important air contaminant in urban atmospheres. In the stratosphere, ozone blocks harmful ultraviolet radiation. In the urban atmosphere, its formation from anthropogenic emissions of hydrocarbons and nitrogen oxides leads to concentrations harmful to people, animals, plants, and materials. Ozone causes significant physiological and pathological changes in both animals and humans at concentrations present in many urban environments. Short-term *(1-2 hours)* exposures to concentrations in the range of 0.1 to 0.4 parts per million induce the following changes in lung function: increased respiratory rates, increased pulmonary resistance, decreased tidal volumes, and changes in lung mechanics. Symptomatic responses in exercising adults include throat dryness, chest tightness, substernal pain, cough, wheeze, pain on deep inspiration, shortness of breath, and headache. These symptoms also have been observed at lower concentrations for longer exposures. Evidence suggests that ozone exposure makes the respiratory airways more susceptible to other bronchoconstrictive challenges. Animal studies suggest that ozone exposure interferes with or inhibits the immune system. Ozone at ambient concentrations injures the stomates, the cells that regulate plant respiration, resulting in flecks on the upper leaf surfaces of dichotomous plants and the death of the tips of coniferous needles. Ozone is considered by plant scientists to be the most important of all of the phytotoxic air pollutants, causing over 90 percent of all plant injury from air pollution on a global basis.

Ozone is formed photochemically by the reaction of volatile organic compounds and nitrogen oxides. Volatile organic compound *(VOC)* emissions in greater Phoenix come from cars and trucks *(31 percent)*, off-road vehicles and equipment such as lawn mowers *(27 percent)*, small stationary sources *(20 percent)*, biogenic emissions from grass, shrubs, and trees *(17 percent)*, and point sources *(5 percent)*. Nitrogen oxides *(NOx)* come from cars and trucks *(58 percent)*, off-road vehicles such as construction equipment and trains *(27 percent)*, electric power plants *(7 percent)*, small stationary sources *(4 percent)*, and biogenic emissions from soil *(4 percent)*. Ozone has relatively high background levels, with the daily maximum in remote areas being about one-half to three-quarters of the daily maximum in the urban areas. Within an urban area, the highest ozone concentrations tend to occur on the downwind edge, although high concentrations do occur less frequently in the central city. High ozone concentrations are a summer phenomenon, when sunlight and evaporative hydrocarbon emissions peak. Ozone concentrations are low to near zero at night, rise rapidly through the morning, and peak in the afternoon.

Controls to reduce the precursors of ozone — VOC and NOx — have been carried out successfully for years. Nitrogen oxides and exhaust VOC from vehicles have been reduced through engine modifications and three-way catalytic converters. Evaporative hydrocarbons from vehicles have been reduced through better engineered fuel tanks and auxiliary plumbing combined with carbon absorption canisters. Additional reductions of vehicular VOC have come through the Vehicle Inspection and Maintenance Program, which tests all gasoline vehicles for hydrocarbons *(Phoenix and Tucson)*, through vapor-capturing equipment for gasoline tankers, through vapor recovery systems at retail gas stations *(Phoenix area only)*, and through reformulated gasoline *(Maricopa County only)*. Stationary source hydrocarbons have been reduced through a variety of better control equipment required by stricter regulations. Despite these efforts, the continued growth in Arizona, combined with the high natural background ozone, will make achieving the eight-hour standard a difficult proposition.

Ozone is monitored continuously with ultraviolet absorption instruments in urban neighborhoods for population exposure, in areas downwind of urban areas for maximum concentration monitoring, and in remote areas for background information. Of the 37 ozone monitors in operation in 1998, five were for background, 22 for urban neighborhoods, and 10 for maximum concentrations downwind of urban areas. The National Ambient Air Quality Standard for ozone is 0.12 parts per million for a one-hour average, with not more than three exceedances allowed in any three-year period at a single site. The U. S. Environmental Protection Agency *(EPA)* promulgated a new ozone standard in 1997, expressed as an eight-hour average of 0.08 parts per million, for the three-year average of the annual fourth-highest concentrations. This eight-hour standard was developed in response to human exposure studies that showed adverse health effects at lower concentrations than the one-hour standard. In a May 14, 1999, decision bythe U. S. Court of Appeals for the District of Columbia, this standard was remanded to EPA for further consideration. The one-hour standard was last exceeded in 1996 in Phoenix; the eight-hour standard is exceeded at several sites in the Phoenix metropolitan area. **Tables II-5** through **II-8** present the ozone data collected in Arizona in 1998.

TABLE II-5
1998 OZONE DATA (*IN PPM*)
1-HOUR AVERAGES

Standard:
Average number of days per calendar year with maximum 1-hour average ≤ .124 ppm and with no more than 3 exceedances in a 3-year period

1998 1-hour Ozone Exceedances by County:

Apache	0	Pima	0
Cochise	0	Pinal	0
Coconino	0	Yavapai	0
Gila	0	Yuma	0
Maricopa	0		

SUMMARY: 36 of 36 monitors in compliance

COUNTY AND CITY OR SITE	1-HR AVERAGE MAX	2ND HIGHEST	3RD HIGHEST	4TH HIGHEST	NUMBER OF SAMPLE DAYS	HOURS
APACHE:						
St. Johns- Mesa Parada	.070	.066	NA	NA	NA	8185
COCHISE:						
Chiricahua National Monument	.081	.077	.073	.073	350	7824
COCONINO:						
Grand Canyon National Park - Hopi Pt.	.077	.076	.075	.075	361	8223
Page	.070	.070	NA	NA	NA	8634
GILA:						
Rye [a, b]	.081	.080	.076	.073	73	1708
MARICOPA:						
Blue Point	.115	.111	.106	.105	355	8461
West Chandler	.094	.093	.088	.084	353	8128
Fountain Hills	.123	.109	.104	.104	360	8612
Glendale	.093	.092	.085	.084	360	8255
Humboldt Mountain	.116	.102	.100	.100	351	8373
Lake Pleasant	.104	.098	.095	.093	195	4697
Mesa - Falcon Field	.111	.103	.101	.099	358	8524
Mesa	.101	.100	.098	.096	364	8367
Mt. Ord - MCESD	.104	.101	.099	.098	340	8176
Palo Verde [b]	.099	.092	.091	.090	NA	4574
Phoenix - Emergency Management	.100	.099	.094	.093	352	8427
Central Phoenix	.101	.100	.100	.099	349	8022

COUNTY AND CITY OR SITE	1-HR AVERAGE MAX	2[ND] HIGHEST	3[RD] HIGHEST	4[TH] HIGHEST	NUMBER OF SAMPLE DAYS	HOURS
MARICOPA *(Cont'd)*						
North Phoenix	.120	.113	.111	.109	357	8189
West Phoenix	.117	.112	.111	.104	364	8337
South Phoenix	.107	.101	.100	.098	349	8005
Phoenix [b] - JLG Super Site	.104	.102	.099	.095	NA	5739
Phoenix - Maryvale	.114	.112	.099	.098	352	8409
Pinnacle Peak	.114	.112	.107	.105	361	8585
Rio Verde	.103	.099	.094	.094	17	395
South Scottsdale	.106	.098	.093	.093	347	7946
Salt River - Pima [b]	.115	.108	.107	.105	172	4237
PIMA:						
Saguaro Park	.099	.094	.089	.088	362	8676
Tucson - Downtown	.079	.078	.076	.076	350	8401
Tucson - Craycroft	.104	.094	.091	.091	364	8699
Tucson - Fairgrounds	.088	.087	.085	.083	351	8396
Tucson - Children's Park [a]	.086	.086	.085	.082	360	8616
Tucson - Tangerine	.095	.089	.081	.079	360	8631
PINAL:						
Apache Junction Highway Yard	.112	.112	.111	.106	NA	8377
Casa Grande Airport	.093	.079	.076	.075	NA	8478
YAVAPAI:						
Hillside [b]	.090	.090	.087	.087	192	4570
YUMA:						
Yuma [b]	.109	.101	.095	.094	144	3469

Footnotes: a - New site b - Site operated on a seasonal basis NA - Not Available

Table II-6
1996 - 1998 Ozone Compliance *(in ppm)*
1-Hour Average

Standard: The 4th highest 1-hour concentration in three years must not exceed .124 ppm

COUNTY AND CITY OR SITE	HIGHEST	2ND HIGHEST	3RD HIGHEST	4TH HIGHEST	PERCENT OF STANDARD
APACHE:					
St. Johns- Mesa Parada	.075	.074	.070	.070	5
COCHISE:					
Chiricahua National Monument [a]	.081	.077	.073	.073	5
COCONINO:					
Grand Canyon National Park - Hopi Pt.	.084	.082	.080	.077	62.1
Page	.074	.073	.070	.070	56.5
GILA:					
Rye [a]	.081	.080	.076	.073	58.9
MARICOPA:					
Arrowhead	.114	.114	.113	.113	91.1
Blue Point	.140	.132	.128	.122	99.1
West Chandler	.118	.115	.104	.104	84.5
Fountain Hills	.132	.132	.128	.126	101.7
Glendale	.098	.096	.095	.093	75.3
Humboldt Mountain	.116	.102	.100	.100	80.6
Lake Pleasant [a]	.104	.098	.095	.093	75.0
Mesa - Falcon Field	.126	.118	.118	.116	93.6
Mesa	.126	.118	.118	.116	93.6
Mount Ord	.129	.128	.118	.116	94.0
Palo Verde	.099	.099	.096	.094	75.8
Phoenix - Emergency Management	.123	.119	.117	.113	91.5
Central Phoenix	.101	.100	.100	.099	80.6
North Phoenix	.124	.126	.120	.120	96.8

TABLE II-6 *(CONT'D)*
1996 - 1998 OZONE COMPLIANCE *(IN PPM)*
1-HOUR AVERAGE

COUNTY AND CITY OR SITE	HIGHEST	2ND HIGHEST	3RD HIGHEST	4TH HIGHEST	PERCENT OF STANDARD
MARICOPA *(cont'd)*:					
West Phoenix	.117	.112	.111	.104	83.9
South Phoenix	.124	.119	.118	.116	94.2
Phoenix - JLG Super Site	.110	.110	.109	.104	83.9
Phoenix - Maryvale	.114	.112	.107	.103	83.1
Pinnacle Peak	.115	.114	.112	.109	88.4
Rio Verde [b]	.112	.112	.105	.104	84.4
Roosevelt[c]	.112	.104	.104	.102	82.4
South Scottsdale	.114	.112	.111	.111	89.6
Salt River - Pima	.130	.122	.118	.115	92.7
PIMA:					
Saguaro Park	.099	.094	.092	.092	74.2
Tucson - Downtown	.085	.085	.080	.080	64.5
Tucson - Craycroft	.110	.104	.100	.094	75.8
Tucson - Fairgrounds	.088	.087	.085	.084	67.7
Tucson [a] - Children's Park	.090	.090	.086	.086	69.4
Tucson - Tangerine	.095	.090	.082	.081	65.3
PINAL:					
Apache Junction Highway Yard	.121	.115	.112	.112	90.3
Casa Grande Airport	.104	.093	.091	.080	64.5
YAVAPAI:					
Hillside	.101	.090	.090	.087	70.2
YUMA:					
Yuma - College	.109	.101	.100	.100	80.6

Footnotes: a - 1998 only b - 1997-1998 only c - 1997 only
Shaded site *(Fountain Hills only)* exceeds the standard

TABLE II-7
1998 OZONE DATA *(IN PPM)*
8-HOUR AVERAGES

1998 8-hour Ozone Exceedances by County:			
Apache	0	Pima	0
Cochise	0	Pinal	2
Coconino	0	Yavapai	3
Gila	0	Yuma	5
Maricopa	84		

SUMMARY: 17 of 36 monitors in compliance

Standard:
Three-year average of annual 4th-highest daily 8-hour maximum less than or equal to .084 ppm

COUNTY AND CITY OR SITE	8-HR AVERAGE MAX	2ND HIGHEST	3RD HIGHEST	4TH HIGHEST	NUMBER OF DAILY EXCEEDANCES	NUMBER OF SAMPLE DAYS
APACHE:						
St. Johns - Mesa Parada	NA	NA	NA	.063	NA	NA
COCHISE:						
Chiricahua National Monument	.075	.073	.069	.067	0	334
COCONINO:						
Grand Canyon National Park - Hopi Pt.	.073	.073	.073	.072	0	361
Page	NA	NA	NA	.065	NA	NA
GILA:						
Rye [a, b]	.077	.071	.068	.066	0	71
MARICOPA:						
Blue Point	.093	.092	.090	.089	16	350
West Chandler	.079	.075	.075	.074	0	348
Fountain Hills	.094	.093	.088	.086	6	360
Glendale	.073	.072	.071	.070	0	356
Humboldt Mountain	.094	.090	.090	.090	10	347
Lake Pleasant	.088	.085	.082	.082	2	189
Mesa - Falcon Field	.090	.085	.083	.083	2	355
Mesa	.089	.084	.080	.080	1	361
Mount Ord	.092	.090	.089	.088	6	338
Palo Verde [b]	.092	.082	.080	.080	1	185
Phoenix - Emergency Management	.083	.083	.082	.081	0	351
Central Phoenix	.087	.084	.084	.079	1	345

TABLE II-7 (*CONT'D*)
1998 OZONE DATA (*IN PPM*)
8-HOUR AVERAGES

COUNTY AND CITY OR SITE	8-HR AVERAGE MAX	2ND HIGHEST	3RD HIGHEST	4TH HIGHEST	NUMBER OF DAILY EXCEEDANCES	NUMBER OF SAMPLE DAYS
MARICOPA (*Cont'd*)						
North Phoenix	.095	.094	.090	.089	10	354
West Phoenix	.103	.093	.093	.086	7	364
South Phoenix	.089	.083	.082	.080	1	343
Phoenix [b] - JLG Super Site	.082	.080	.080	.078	0	235
Phoenix - Maryvale	.098	.090	.089	.086	4	352
Pinnacle Peak	.095	.089	.087	.086	7	360
Rio Verde	.089	.088	.088	.079	3	16
South Scottsdale	.084	.083	.079	.078	0	343
Salt River - Pima [b]	.090	.089	.088	.087	7	171
PIMA:						
Saguaro Park	.079	.078	.077	.076	0	362
Tucson - Downtown	.066	.064	.064	.062	0	347
Tucson - Craycroft	.080	.080	.077	.073	0	364
Tucson - Fairgrounds	.072	.072	.071	.071	0	350
Tucson [a] - Children's Park	.077	.073	.073	.072	0	359
Tucson - Tangerine	.072	.072	.071	.070	0	360
PINAL:						
Apache Junction Highway Yard	.092	.089	.083	.083	2	NA
Casa Grande Airport	.066	.066	.064	.064	0	NA
YAVAPAI:						
Hillside [a]	.088	.087	.085	.083	3	184
YUMA:						
Yuma - College [a]	.095	.090	.089	.089	5	144

Footnotes: a - New site b - Seasonal Monitor (April - October) NA - Not Available

Table II-8
1996 - 1998 Ozone Compliance *(in ppm)*
Annual Fourth Highest 8-Hour Averages

Standard: Three-year average of annual 4th-highest daily 8-hour maximum less than or equal to .084 ppm

County and City or Site	1996	1997	1998	3-Year Average
APACHE:				
St. Johns - Mesa Parada	NA	.057	.063	NA
COCHISE:				
Chiricahua National Monument	NA	.065	.067	NA
COCONINO:				
Grand Canyon National Park - Hopi Point	NA	.073	.072	NA
Page	NA	.063	.065	NA
GILA:				
Rye [a, b]	NA	.057	.065	NA
MARICOPA:				
Blue Point	.098	.084	.089	.090
West Chandler	.086	.078	.074	.079
Fountain Hills	.090	.089	.086	.088
Glendale	.073	.077	.070	.073
Humboldt Mountain	.092	.082	.090	.088
Lake Pleasant	NA	NA	.082	NA
Mesa - Falcon Field	.090	.082	.083	.085
Mesa	.091	.083	.080	.085
Mount Ord	.098	.085	.088	.090
Palo Verde [b]	.066	.078	.080	.075
Phoenix - Emergency Management	.095	.086	.081	.087
Central Phoenix	.077	.078	.079	.078
North Phoenix	.097	.092	.089	.093
West Phoenix	.081	.092	.086	.086
South Phoenix	.093	.075	.080	.083
Phoenix [b] - JLG Supersite	.085	.080	.078	.081

COUNTY AND CITY OR SITE	1996	1997	1998	3-YEAR AVERAGE
MARICOPA *(cont'd)*:				
Phoenix - Maryvale	.087	.078	.086	.084
Pinnacle Peak	.092	.083	.086	**.087**
Rio Verde	NA	.086	.079	NA
South Scottsdale	.088	.077	.078	.081
Salt River - Pima [b]	.094	.083	.087	**.088**
PIMA:				
Saguaro Park	.076	.080	.076	.077
Tucson - Downtown	.069	.065	.062	.065
Tucson - Craycroft	.077	.077	.073	.076
Tucson - Fairgrounds	.070	.066	.071	.069
Tucson [a] - Children's Park	NA	.065	.072	NA
Tucson - Tangerine	.071	.070	.070	.070
PINAL:				
Apache Junction Highway Yard	.085	.082	.083	.083
Casa Grande Airport	.070	.072	.069	.070
YAVAPAI:				
Hillside [b]	.086	.078	.083	.082
YUMA:				
Yuma - College [b]	.076	.078	.089	.081

Footnotes: a - New site; b - Seasonal Monitor *(April - October)*
NA = Not Available; Shaded bold value exceeds standard

Particulate Matter Smaller Than 10 Microns *(PM_{10})* And Smaller Than 2.5 Microns *($PM_{2.5}$)*

"Particulate matter" is a collective term describing very small solid or liquid particles that vary considerably in size, geometry, chemical composition, and physical properties. Produced by both natural processes *(pollen, wind erosion)* and human activity *(soot, flyash, dust from paved and unpaved roads)*, particulates contribute to visibility reduction, pose a threat to public health, and cause economic damage through soiling. Some fine particulates *($PM_{2.5}$)* are formed by the condensation of vapors or by their subsequent growth through coagulation or agglomeration. Others are emitted directly from the sources, either combustion or from mechanical grinding of soils. Coarse particulates *(2.5 to 10 microns)* are formed through mechanical processes such as the grinding of matter and the atomization of liquids. Fine particulates can also be classified as primary — produced within and emitted from a source with little subsequent change — or secondary — formed in the atmosphere from gaseous emissions. Secondary particulate nitrates and sulfates, for example, form in the atmosphere from the oxidation of sulfur dioxide and nitric oxide gases. Most atmospheric carbon, on the other hand, is primary, having been emitted directly from combustion sources, although some of the organic carbon in the aerosol is secondary, having been formed by the complex photochemistry of gaseous volatile organic compounds.

The health effects of particulates depend on their size, shape, and chemical composition. Particles larger than 10 microns are deposited in the upper respiratory tract. Particles from 2.5 to 10 microns are inhalable and are deposited in the upper parts of the respiratory system. Particles smaller than 2.5 microns are respirable and enter the pulmonary tissues to be deposited there. Particles in the size range of 0.1 to 2.5 microns are most efficiently deposited in the alveoli, where their effective toxicity is greater than larger particles because of the higher relative content of toxic heavy metals, sulfates, and nitrates. Epidemiological studies have shown causal relationships between particulates and excess mortality, aggravation of bronchitis, and small reversible changes in pulmonary function in children. Acidic aerosols have been linked to the inability of the upper respiratory tract and pulmonary system to remove harmful particles.

The Arizona Comparative Environmental Risk Project — a multidisciplinary investigation into human exposure to all environmental risks that was completed in 1995— ranked outdoor air quality in general and particulate matter in particular, as the highest environmental risk in the state. Annual premature deaths from exposure to PM_{10} concentrations in Arizona were estimated at 963, including 667 in Maricopa County and 88 in Tucson. Increased percentages of hospital admissions for respiratory disease *(1 to 4 percent, depending on the city)*, of asthma episodes *(5 to 14 percent)*, of lower respiratory symptoms *(5 to 15 percent)*, and of coughs *(2 to 6 percent)* were attributed to the prevailing *(1991)* annual PM_{10} concentrations. Chronically high particulates concentrations in the ambient air continue to pose a serious health threat to many Arizonans.

Coarse particulate emissions are mostly geological and are dominated by dusts from three activities: reentraining dust from paved roads, driving on unpaved roads, and earthmoving associated with construction. Soil dust from these sources and others contribute more that 70 percent of the coarse particulates in Phoenix. On days with winds in excess of 15 miles per hour, wind erosion of soil contributes to this loading. With a more diverse chemical composition, fine particulates *($PM_{2.5}$)* emissions are more evenly distributed among a larger number of sources. At the Phoenix JLG Supersite, receptor modeling indicates gasoline and diesel engine exhaust account for more that two-thirds of the $PM_{2.5}$ emissions. Soil dust contributes another 10.5 percent. In other urban and rural areas, this mixture of sources will vary: agricultural and mining areas, for example, will be more heavily influenced by emissions from these activities.

$PM_{2.5}$ concentrations tend to be at their highest in the central portions of urban areas, diminishing to background levels at the urban fringe. In contrast, PM_{10} concentrations are not smoothly spatially distributed, because each monitoring site is strongly influenced by the degree of localized emissions of coarse particulates. Background concentrations of PM_{10} are about 40 percent of the urban maxima *(20 $\mu g/m^3$ for an annual average background versus about 50 $\mu g/m^3$ for the urban maximum)*. Background concentrations of $PM_{2.5}$ are about 5 $\mu g/m^3$, in contrast to the urban maxima of 12 to 15 $\mu g/m^3$. Concentrations of both size ranges of particulates tend to be higher in the late fall and winter, when atmospheric dispersion is at a seasonal low. PM_{10} maximum concentrations can occur in any season, provided nearby sources of coarse particulates are present or when strong and gusty winds suspend soil disturbed by human activities. Hourly concentrations of particulates tend to peak during those hours of the poorest dispersion: from sunset to mid-morning.

Controls to reduce particulates have been in place for decades, beginning with an ordinance that required watering to reduce dust from construction in Pima County in the 1960s. Maricopa County's umbrella dust abatement rule, Rule 310, has gone through many additions through the years, and now is regulating construction dust, track-out dust from construction sites, and dust from unpaved parking lots. Efforts to reduce dust resuspended from paved roads have concentrated on eliminating track-out from construction sites, curbing and stabilizing road shoulders, and investigating more efficient street sweepers. Secondary fine particulates have been reduced by vehicular emission controls that have reduced their precursor gases. Reducing gaseous hydrocarbon emissions has led to a significant reduction in the primary carbon emitted in motor vehicle exhaust. In Maricopa County, the Governor's Agricultural Best Management Practices Advisory Committee is developing best management practices for agricultural activities intended to reduce particulate emissions from tilling, harvesting, and other activities. In a recent PM_{10} control plan, the Maricopa Association of Governments received commitments to implement 77 new measures, including better enforcement of the dust rules, agricultural best management practices, diesel engine replacement and retirement programs, cleaner burning fireplaces, and stricter standards for utility equipment.

Particulates are monitored by pulling ambient air through a filter, generally for 24 hours every sixth day, weighing the filter before and after, and measuring the volume of air sampled. Instruments are fitted with different aerodynamic devices to segregate different particle size fractions. Particulates are also monitored continuously, with a Tapered Element Oscillating Microbalance *(TEOM)* instrument. PM_{10} was monitored at 88 sites throughout Arizona in 1998, three by the continuous TEOM instrument. The National Ambient Air Quality Standards for PM_{10} are 50 $\mu g/m^3$ for the three-year average of annual averages and 150 $\mu g/m^3$ for the three-year average of the annual 99th percentile values of the 24-hour averages.

$PM_{2.5}$ was monitored at 41 sites in 1998. Its air quality standards are 15 $\mu g/m^3$ for an annual average and 65 $\mu g/m^3$ for the 98^{th} percentile value of the 24-hour average. As was the case with ozone, the District of Columbia Court of Appeals May 1999, decision remanded the PM_{10} and $PM_{2.5}$ standards to EPA for reconsideration.

Monitored exceedances of the particulates standards are rare in Arizona: neither $PM_{2.5}$ standard was exceeded at any site; for PM_{10}, one site equaled the annual standard *(27th Avenue and I-10, Phoenix)*, one site exceeded both standards *(the rodeo grounds at Eleven Mile Corner, in Pinal County)*, and one site exceeded the 24-hour standard *(the U.S. Post Office in Nogales)*. Despite the rareness of recorded exceedances, concentrations of particulates do exceed the air quality standards. The 24-hour average standards are exceeded more often than the monitoring record indicates, because the monitoring at most sites is conducted only every sixth day. Both short and long-term standards are violated on a regular basis wherever localized sources of emissions are strong. Typically these emissions come from such activities as earthmoving, agriculture, unpaved roads, and heavy traffic on paved roads. The consequent elevated particulates concentrations are usually limited to the vicinity of these sources. **Tables II-9** and **II-10** present the PM_{10} and $PM_{2.5}$ data collected in Arizona in 1998. **Tables II-11** and **II-12** present 1996, 1997, and 1998 data for annual average PM_{10} and for the maximum 24-hour average PM_{10}. Please note that TEOM data are not included in these tables.

TABLE II-9
1998 PM_{10} DATA (*IN UG/M³*)

1998 PM10 Exceedances by County:	Annual	24-hr		Annual	24-hr
Apache	0	0	Navajo	0	0
Cochise	0	0	Pima	0	0
Coconino	0	0	Pinal	1	1
Gila	0	0	Santa Cruz	0	1
Graham	0	0	Yavapai	0	0
Maricopa	0	0	Yuma	0	0
Mohave	0	0			

SUMMARY: 77 of 79 monitors in compliance

Standards:

Annual 3-year average of annual averages less than or equal to 50 ug/m³

24-Hour 3-year average of annual 99th percentile is less than or equal to 150 ug/m³

COUNTY AND CITY OR SITE	METHOD	ANNUAL AVERAGE	24-HR AVERAGES: MAX	24-HR AVERAGES: 2ND HIGHEST	24-HR AVERAGES: 99TH PERCENTILE	NUMBER OF SAMPLES
APACHE:						
St Johns - Mesa Parada	Dichot	7	17	16	17	57
St. Johns - Carrizo Draw	Dichot	10	36	29	36	59
Springerville - Coyote Hills	Dichot	8	25	21	21	111
Springerville - 15 mi NE	Dichot	9	26	24	24	112
COCHISE:						
Douglas[b] - High School	Dichot	28[c]	61	59	61	24
Douglas - Red Cross	Dichot	32	105	60	105	18
Naco	Hi-Vol	34	116	94	116	55
Paul Spur	Dichot	36	82	81	82	51
COCONINO:						
Flagstaff - ADOT	Wedding	12	33	22	33	58
Flagstaff - Middle School	Dichot	13	30	29	30	50
Sedona	Hi-Vol	10	54	20	54	57
GILA:						
Hayden - Old Jail	Dichot	28	78	62	78	62
Miami - Golf Course	Dichot	23	51	46	51	60
Miami - Ridgeline	Dichot	11	27	19	27	61
Payson	Dichot	24	69	57	69	58
GRAHAM:						
Safford	Hi-Vol	27[c]	98	63	98	57
MARICOPA:						
Chandler	Hi-Vol	45	136	104	136	52

Table II-9 (*cont'd*)
1998 PM_{10} Data (*in ug/m^3*)

County and City or Site	Method	Annual Average	24-Hr Averages: Max	2nd Highest	99th Percentile	Number of Samples
MARICOPA *(cont'd)*						
West Chandler	Hi-Vol	34	78	74	78	61
Gilbert	Hi-Vol	42	133	91	133	55
Glendale	Hi-Vol	29	61	57	61	56
Estrella	Dichot	25	56	56	56	61
Higley	Dichot	50	135	116	135	61
Phoenix - Maryvale	Hi-Vol	36	92	83	92	59
Mesa	Hi-Vol	29	64	61	64	61
Palo Verde	Dichot	19	47	46	47	55
South Phoenix [b]	Hi-Vol	-- [c]	77	67	77	25
West Phoenix	Hi-Vol	39	107	106	107	57
Phoenix - Salt River [b]	Hi-Vol	-- [c]	NA	NA	NA	25
Central Phoenix [b]	Hi-vol	-- [c]	70	62	70	23
North Phoenix	Hi-Vol	29	67	62	67	57
Phoenix - JLG Super Site	Dichot	31	69	67	69	54
Phoenix - Greenwood - ADEQ	Dichot	43	106	95	106	37
Phoenix - Greenwood - MCESD	Hi-Vol	50	121	115	121	61
Phoenix - ASU West	Dichot	25	55	53	55	61
South Scottsdale	Hi-Vol	34	81	66	81	58
Tempe	Dichot	31	70	68	70	61
Wickenburg	Hi-Vol	-- [c]	55	42	55	17
MOHAVE:						
Bullhead City - Alonas Way	Hi-Vol	22	76	46	76	55
Bullhead City - Hwy. 95	Dichot	11	27	26	27	56
Fort Mohave	Dichot	12	39	24	39	55
Kingman - Praxair	Hi-Vol	12	70	31	70	46

TABLE II-9 *(CONT'D)*
1998 PM_{10} DATA *(IN UG/M^3)*

COUNTY AND CITY OR SITE	METHOD	ANNUAL AVERAGE	24-HR AVERAGES: MAX	2ND HIGHEST	99TH PERCENTILE	NUMBER OF SAMPLES
NAVAJO:						
Joseph City - Third and Tanner	Wedding	11	26	23	26	60
Show Low	Wedding	11 [c]	27	26	27	47
PIMA:						
Ajo	Dichot	21	65	51	65	51
Tucson - Corona de Tucson	Hi-Vol	14	41	36	41	60
Green Valley - PDEQ	Hi-Vol	14	32	30	32	61
Organ Pipe Cactus National Monument	Dichot	8	22	18	22	56
Rillito - ADEQ	Dichot	30	74	68	74	61
Rillito - APCC	Wedding	29	79	65	65	106
Tucson - Broadway and Swan	Hi-Vol	24	49	49	49	61
Tucson - Santa Clara	Hi-Vol	25	50	41	50	50
Tucson - Downtown	Hi-Vol	29	90	73	69	236
Tucson - Orange Grove	Dichot	24	44	41	44	60
Tucson - Prince Road	Hi-Vol	33	83	66	83	59
South Tucson	Hi-Vol	36	79	67	79	61
Tucson - Craycroft	Dichot	21	51	37	51	61
Tucson - Tangerine	Dichot	12	29	25	29	60
Tucson - Fairgrounds	Dichot	14	44	30	44	61
Tucson - U of A Central	Dichot	23	48	45	48	61
Tucson - Sabino	Wedding	18	32	31	32	43
PINAL:						
Apache Junction - South County Courthouse	Wedding	24	61	53	61	60
Apache Junction - North County Courthouse	Wedding	25	62	53	62	60
Casa Grande	Wedding	30	74	62	74	54

TABLE II-9 *(CONT'D)*
1998 PM_{10} DATA *(IN UG/M³)*

COUNTY AND CITY OR SITE	METHOD	ANNUAL AVERAGE	24-HR AVERAGES: MAX	2ND HIGHEST	99TH PERCENTILE	NUMBER OF SAMPLES
PINAL *(cont'd)*						
Coolidge	Wedding	36	134	126	134	59
Casa Grande - County Fairgrounds- Eleven Mile Corner	Hi-Vol	51	159	137	159	56
Eloy	Hi-Vol	41	103	75	103	48
Mammoth	Hi-Vol	22	47	46	47	55
Pinal Air Park - Marana	Hi-Vol	26	63	63	63	51
Maricopa	Hi-Vol	34	68	66	68	29
Stanfield	Wedding	40	104	102	104	54
SANTA CRUZ:						
Nogales - Post Office	Dichot	38	155	144	155	50
YAVAPAI:						
Clarkdale - SE of CTI Flyash Silo	Dichot	25	51	50	51	61
Clarkdale - ADEQ	Dichot	15	26	26	26	51
Clarkdale - NW of Cement Plant	Dichot	19	82	56	82	61
Hillside	Dichot	12	20	19	20	46
Montezuma Castle National Monument	Dichot	12	26	21	26	49
Nelson	Dichot	11	53	46	53	52
Prescott	Wedding	12	25	25	25	53
YUMA:						
Yuma - Juvenile Center	Dichot	39	109	103	109	58

Footnotes: a - New site b - Site terminated
c - Invalid annual average due to insufficient number of samples
NA - Not Available

TABLE II-10
1998 $PM_{2.5}$ DATA *(IN UG/M^3)*

1998 PM2.5 Exceedances by County:	Annual	24-hr		Annual	24-hr
Apache	0	0	Mohave	0	0
Cochise	0	0	Pima	0	0
Coconino	0	0	Santa Cruz	0	0
Gila	0	0	Yavapai	0	0
Maricopa	0	0	Yuma	0	0

SUMMARY: 36 of 36 monitors in compliance

Standards:

Annual: arithmetic mean is less than or equal to 15 ug/m^3 24-Hour: 98th percentile value is less than or equal to 65ug/m^3

COUNTY AND CITY OR SITE	METHOD	ANNUAL AVERAGE	24-HR AVERAGE 98TH PERCENTILE	NUMBER OF SAMPLES
APACHE:				
St Johns - Mesa Parada	Dichot	3.4	8	57
St. Johns - Carrizo Draw	Dichot	3.7	8	59
Springerville - Coyote Hills	Dichot	4.0	10	111
Springerville - Plant Site	Dichot	4.0	10	112
COCHISE:				
Douglas - High School	Dichot	6.8	12	24
Paul Spur	Dichot	11.6	11	18
COCONINO:				
Flagstaff - Middle School	Dichot	4.7	8.1	51
GILA:				
Hayden - Old Jail	Dichot	8.9	21.0	61
Miami - Golf Course	Dichot	6.3	10.2	60
Miami - Ridgeline	Dichot	4.2	7.7	61
Payson	Dichot	10.9	34.1	58
MARICOPA:				
Higley	Dichot	9.4	18.1	61
Estrella	Dichot	7.1	18.5	61
Mt. Ord - NPS	IMPROVE	3.6	9.8	84
Palo Verde	Dichot	5.5	10.4	55
Phoenix - Greenwood	Dichot	14.7 [b]	47.1	37
Phoenix - Super Site	Dichot	10.9	28.2	54
Phoenix - ASU West	Dichot	8.3	21.8	61
Tempe	Dichot	9.4	23.3	61

TABLE II-10 *(CONT'D)*
1998 $PM_{2.5}$ DATA *(IN UG/M³)*

COUNTY AND CITY OR SITE	METHOD	ANNUAL AVERAGE	24-HR AVERAGE 98TH PERCENTILE	NUMBER OF SAMPLES
MOHAVE:				
Bullhead City	Dichot	3.5	14.1	56
Fort Mohave	Dichot	4.3	8.9	55
PIMA:				
Organ Pipe CactusNational Monument	Dichot	3.7	6.8	56
Saguaro National Park West Unit	IMPROVE	4.9	12.5	93
Tucson - Orange Grove	Dichot	7.3	14.3	60
Tucson - Craycroft	Dichot	6.3	12.3	61
Tucson - Tangerine	Dichot	4.6	10.1	60
Tucson - Fairgrounds	Dichot	5.0	10.2	61
Tucson - U of A Central	Dichot	7.5	15.4	61
SANTA CRUZ:				
Nogales	Dichot	12.5	34.4	50
YAVAPAI:				
Clarkdale - SE of CTI Flyash Silo	Dichot	5.1	11.3	61
Clarkdale - School	Dichot	4.5	6.8	52
Clarkdale - NW of Cement Plant	Dichot	4.7	11.3	61
Hillside	Dichot	3.1	5.6	46
Montezuma Castle [a]	Dichot	4.5 [b]	7.6	49
Nelson	Dichot	3.6	7.1	52
YUMA:				
Yuma	Dichot	8.3 [b]	15.5	58

Footnotes: a - Site terminated
b - Invalid annual average due to insufficient number of samples
NA - Not Available

TABLE II-11
1996 - 1998 PM_{10} COMPLIANCE (*IN UG/M³*)
ANNUAL AVERAGES

Standard: 3-year average of annual averages less than or equal to 50 ug/m³
Shaded sites violate the standard

COUNTY AND CITY OR SITE	ANNUAL AVERAGES 1996	1997	1998	3-YEAR AVERAGE
APACHE:				
Petrified Forest National Monument	8	9	NA	NA
St Johns - Mesa Parada	6	7	7	6.7
St. Johns - Carrizo Draw	9	8	10	9.0
Springerville - Coyote Hills	8	8	8	8.0
Springerville - 15 mi NE	10	10	9	9.7
COCHISE:				
Chiricahua National Monument	10	9	NA	NA
Douglas[c] - High School	32	26	28	28.7
Naco	32[c]	33	34	33.0
Paul Spur	36	39	36	37.0
COCONINO:				
Flagstaff - ADOT	14	15	12	13.7
Flagstaff - Middle School	14	15	13	14.0
Grand Canyon National Park - Hopi Point	9	8	NA	NA
Grand Canyon National Park- Indian Gardens	11	14	NA	NA
Sedona	9[a]	11	10	10.0
GILA:				
Hayden - Old Jail	41	36	28	35.0
Miami - Golf Course	30	27	23	26.7
Miami - Ridgeline	14	14	11	13.0
Payson	30	25	24	26.3
Tonto National Monument	14	12	NA	NA

Table II-11 *(cont'd)*
1996 - 1998 PM_{10} Compliance *(in ug/m^3)*
Annual Averages

County and City or Site	Annual Averages 1996	1997	1998	3-Year Average
GRAHAM:				
Safford	40	29	27	32.0
MARICOPA:				
Chandler	62	61	45	56.0
West Chandler	NA	45	34	NA
Gilbert	54	49	42	48.3
Glendale	34	38	29	33.7
Estrella	31	35	25	30.3
Higley	57	64	50	57.0
Maryvale	NA	49	36	NA
Mesa	33	43	29	35.0
Palo Verde	NA	20	19	NA
South Phoenix	47	55	NA	NA
West Phoenix	45	51	39	45.0
Central Phoenix	41	44	NA	NA
North Phoenix	37	38	29	34.7
Phoenix - Super Site	34	39	31	34.7
Phoenix - Greenwood	NA	NA	43	NA
Phoenix - County Greenwood	NA	61	50	NA
Phoenix - ASU West	31	34	25	30.0
South Scottsdale	35	41	34	36.7
Tempe	57	36	31	41.3
Wickenburg	NA	36	NA	NA
MOHAVE:				
Bullhead City - Alonas Way	24	21	22	22.3
Bullhead City - Highway 95	35	NA	11	15.3
Fort Mohave	17	15	12	14.7

TABLE II-11 *(CONT'D)*
1996 - 1998 PM_{10} COMPLIANCE *(IN UG/M^3)*
ANNUAL AVERAGES

COUNTY AND CITY OR SITE	ANNUAL AVERAGES 1996	1997	1998	3-YEAR AVERAGE
KINGMAN *(cont'd)*				
Kingman	12	12	12	12.0
NAVAJO:				
Joseph City	14	15	11	13.3
Show Low	12	16	11	13.0
PIMA:				
Ajo	21	20	21	20.7
Tucson - Corona de Tucson	13	15	14	14.0
Green Valley	15	16	14	15.0
Organ Pipe Cactus National Monument	11	10	8	9.7
Rillito - APCC	39	40	30	36.3
Rillito - ADEQ	31	26	29	28.7
Tucson - Broadway & Swan	25	28	24	25.7
Tucson - Santa Clara	28	27	25	26.7
Tucson - Downtown	33	29	29	30.3
Tucson - Orange Grove	32	31	24	29.0
Tucson - Prince Road	36	34	33	34.3
South Tucson	31	33	36	33.3
Tucson - Craycroft	23	26	21	23.3
Tucson - Tangerine	14	15	12	13.7
Tucson - Fairgrounds	15	16	14	15.0
Tucson - U of A Central	28	27	23	26.0
Tucson - Sabino	18	17	18	17.7
PINAL:				
Apache Junction - South Courthouse	20	25	24	23.0
Apache Junction - North Courthouse	20	28	25	24.3
Casa Grande	30	35	30	31.7

TABLE II-11 *(CONT'D)*
1996 - 1998 PM_{10} COMPLIANCE *(IN UG/M³)*
ANNUAL AVERAGES

COUNTY AND CITY OR SITE	ANNUAL AVERAGES 1996	1997	1998	3-YEAR AVERAGE
PINAL *(cont'd)*				
Coolidge	34	41	36	37.0
Casa Grande - County Fairgrounds - Eleven Mile Corner	66	62	51	59.7
Eloy	35	44	41	40.0
Mammoth	20	22	22	21.3
Marana	22	26	26	24.7
Maricopa	46	73	34	51.0
Stanfield	33	53	40	42.0
SANTA CRUZ:				
Nogales - Post Office	42 [a]	31	38	37.0
YAVAPAI:				
Clarkdale - SE of CTI Flyash Silo	NA	24	25	NA
Clarkdale - School	16	15	15	15.3
Clarkdale - NW of Cement Plant	22	24	19	21.7
Hillside	10[c]	12	12	11.3
Montezuma Castle	13[c]	12	12	12.3
Nelson	22	14	11	15.7
Prescott	14	14	12	13.3
YUMA:				
Yuma Juvenile Center	36 [a]	36	39	37.0

Footnotes: a - Invalid annual average due to insufficient number of samples
NA - Not Available

Table II-12
1998 PM_{10} Compliance (ug/m^3)
24-Hour Average

24-Hour Standard: 3-year average of annual 99th percentile is less than or equal to 150 ug/m^3

Sites that violate the standard are shaded.

COUNTY AND CITY OR SITE	24-HR AVERAGES 1996	1997	1998	3-YEAR AVERAGE
APACHE:				
Petrified Forest	21	43	NA	NA
St Johns - Mesa Parada	16	18	17	17.0
St. Johns - Carrizo Draw	28	32	36	32.0
Springerville - Coyote Hills	27	19	21	22.3
Springerville - Plant Site	29	33	24	28.7
COCHISE:				
Chiricahua National Monument	27	22	NA	NA
Douglas - High School	74	55	61	63.3
Douglas - Red Cross	NA	NA	105	NA
Naco	101	113	116	110.0
Paul Spur	69	77	82	76.0
COCONINO:				
Flagstaff - E. Railroad St.	42	40	33	38.3
Flagstaff - Middle School	NA	32	30	NA
Grand Canyon National Park - Hopi Point	19	31	NA	NA
Grand Canyon National Park - Indian Gardens	24	58	NA	NA
Sedona	22	24	54	33.3
GILA:				
Hayden - Old Jail	67	158	78	101.0
Miami - Golf Course	64	67	51	60.7
Miami - Ridgeline	25	33	27	28.3
Payson	70	81	69	73.3
Tonto National Monument	34	28	NA	NA

TABLE II-12 *(CONT'D)*
1998 PM_{10} COMPLIANCE (UG/M^3)
24-HOUR AVERAGE

COUNTY AND CITY OR SITE	24-HR AVERAGES			3-YEAR
	1996	1997	1998	AVERAGE
GRAHAM:				
Safford	90	95	98	94.3
MARICOPA:				
Chandler	140	221	136	165.7
West Chandler	NA	194	78	NA
Gilbert	179	170	133	160.7
Glendale	67	170	61	99.3
Goodyear/Estrella	82	179	56	105.7
Higley	NA	288	135	NA
Maryvale	NA	345	92	NA
Mesa	53	129	64	82.0
Palo Verde	NA	124	47	NA
South Phoenix	96	160	77	111.0
West Phoenix	102	224	107	144.3
Phoenix - Salt River	NA	NA	NA	NA
Central Phoenix	105	108	NA	NA
North Phoenix	66	152	67	95.0
Phoenix - Super Site	83	131	69	94.3
Phoenix - Greenwood - MCESD	NA	NA	106	NA
Phoenix - ASU West	58	164	55	92.3
S. Scottsdale	80	154	81	105.0
Tempe	193	90	70	117.7
Wickenburg	NA	125	55	NA
MOHAVE:				
Bullhead City - Alonas Way	79	51	76	68.7
MOHAVE: *(Cont'd)*				

Table II-12 *(cont'd)*
1998 PM_{10} Compliance (*ug/m³*)
24-Hour Average

County and City or Site	24-HR Averages 1996	1997	1998	3-Year Average
Bullhead City - Highway 95	NA	30	27	NA
Fort Mohave	60	68	39	55.7
Kingman	65	32	70	55.7
NAVAJO:				
Joseph City	24	35	26	28.3
Show Low	29	35	27	30.3
PIMA:				
Ajo	61	65	65	63.7
Tucson - Corona de Tucson	25	34	41	33.3
Green Valley	28	42	32	34.0
Organ Pipe CactusNational Monument	57	75	22	51.3
Rillito - APCC	84	129	74	95.7
Rillito - ADEQ	81	67	65	71.0
Tucson - Broadway & Swan	40	58	49	49.0
Tucson - Santa Clara	62	64	50	58.7
Tucson - Downtown	81	71	69	73.7
Tucson - Orange Grove	62	68	44	58.0
Tucson - Prince Road	79	62	83	74.7
South Tucson	72	72	79	74.3
Tucson - Craycroft	38	63	51	50.7
Tucson - Tangerine	24	40	29	31.0
Tucson - Fairgrounds	74	41	44	53.0
Tucson - U of A Central	53	58	48	53.0
Tucson - Sabino	43	36	32	37.0
PINAL:				
Apache Junction - South Courthouse	37	81	61	59.7

TABLE II-12 *(CONT'D)*
1998 PM_{10} COMPLIANCE *(UG/M^3)*
24-HOUR AVERAGE

COUNTY AND CITY OR SITE	24-HR AVERAGES			3-YEAR
	1996	1997	1998	AVERAGE
Apache Junction - North Courthouse	34	81	62	59.0
Casa Grande	73	188	74	111.7
Coolidge	98	156	134	129.3
Casa Grande - County Fairgrounds - Eleven Mile Corner	160	407	159	242.0
Eloy	81	348	103	177.3
Mammoth	33	46	47	42.0
Marana	48	65	63	58.7
Maricopa	119	855	68	347.3
Stanfield	100	608	104	270.7
SANTA CRUZ:				
Nogales - Post Office	114	126	155	131.7
YAVAPAI:				
Clarkdale - SE of CTI Flyash Silo	79	50	51	60.0
Clarkdale - School	33	33	26	30.7
Clarkdale - NW of Cement Plant	52	63	82	65.7
Hillside	22	85	20	42.3
Montezuma Castle	26	31	26	27.7
Nelson	47	53	53	51.0
Prescott	29	38	25	30.7
YUMA:				
Yuma Juvenile Center	103	108	109	106.7

NA - Not Available

PART III
SPECIAL PROJECTS

Dust Storm Over Metropolitan Phoenix

PART III — SPECIAL PROJECTS

VISIBILITY PROGRAMS:

URBAN HAZE AND CLASS I *(Background)*

The regulatory history of visibility began with the Clean Air Act Amendments of 1977, which addressed visibility impairments from industrial sources. As a part of the subsequent EPA regulations, visibility monitoring was required by states. However, few states chose to develop State Implementation Plans *(SIP)* for visibility, so federal implementation plans were developed. To address the monitoring question, EPA initiated a program called the Interagency Monitoring of PROtected Visual Environments *(IMPROVE)* program. The IMPROVE Steering Committee has historically consisted of federal land management agencies and EPA. Air quality organizations representing state and local governments were added later. Recently, ADEQ has advocated for a more direct role in IMPROVE, which should be resolved in 1999. Since 1987, IMPROVE has characterized conditions at selected Class I areas in the United States. In a few cases, technical studies have been undertaken to identify industrial sources that impact visibility. Class I areas are larger federal wilderness areas and national parks where visibility is deemed a valuable resource. In Arizona, IMPROVE has collected data at Grand Canyon National Park, Petrified Forest National Park, Chiricahua National Monument, and Tonto National Monument *(intended to represent Superstition Wilderness.)* Other Class I areas in Arizona are Mazatzal Wilderness, Sierra Ancha Wilderness, Sycamore Canyon Wilderness, Pine Mountain Wilderness, Mt. Baldy Wilderness, Galiuro Wilderness, Chiricahua Wilderness, and Saguaro National Park Wilderness.

More recently, EPA has expanded its role in reducing visibility impairment by developing regulations for regional haze. Regional haze is airborne particulate that cannot be attributed to a specific industrial source. Draft rules are being reviewed during 1998 and early 1999, and should be completed in mid-1999. In the context of this regulation, monitoring is critical. Ambient data will be used to: establish a baseline; estimate natural conditions; and track long-term trends. These technical analyses will be performed for all Class I areas.

VISIBILITY REPORTING

Visibility monitoring is of three types: aerosol, optical and scene. Aerosol measurements are described elsewhere in this report; however, those measurements are used differently in characterizing visibility impairment. The chemical species that comprise a particulate sample have different extinction efficiencies. Extinction efficiency is the extent to which a particular particle will either scatter or absorb light, thus blocking its path to one's eye. The overall impact of particles can be estimated by summing the effect of all the component species. This method is the primary approach used in the draft national regional haze rule for estimating present visibility and charting trends for future plan reviews.

Quantitative visibility monitoring data from measurement devices described in **Part I** of this report are tracked using three different metrics, or measurement scales. Optical measurements of light scattering and absorption, as well as total light extinction, are used to characterize the components and the sum of visibility impairment, respectively. These data can be represented by using three different measurement scales, each with different units; data from any of the three scales can be converted to the other scales. The three scales are called the deciview, inverse megameters, and visual range. The deciview is similar to the sound measurement, the decibel, that relates humanly-perceptible changes in sound levels to a "Normalized" scale. Visibility is handled in a similar fashion using the deciview, to represent how a human would perceive changes in visibility impairment. The inverse megameter is a direct ratio between the exact amount of light received by a sensor compared to the calibrated amount of light from a transmitter source. The data readings produced by using this scale explain how much light is removed over a viewing path one million *(1,000,000)* meters in length. Thus, it is very sensitive to small changes in visibility impairment. For either the deciview or inverse megameter scales, the greater the number, the dirtier the air appears. Finally, visual range, the most familiar measurement scale, quantifies how far one can see. Visual range can be converted from the deciview or inverse megameter scale data. One of the longest records of visibility conditions is human observation of visual range at airports. Unfortunately, airport visual range data have some bias built into them, since they are collected by human observers rather than instruments; these data are sometimes useful for regional visibility trends.

Because most visibility impairment is caused primarily by particulate matter, it is necessary to know the chemical species that comprise a particulate sample to understand the causes of visibility impairment. These chemical species have different light extinction efficiencies, and come from different sources. Extinction efficiency is the extent to which a particular particle will either scatter or absorb light, thus blocking its path to one's eye. The overall impact of particles can be estimated by summing the effect of all the component species. This method is the primary approach used in the draft national regional haze rule for estimating present visibility and charting trends for future plan reviews. The sum of these data are most often reported in deciviews.

Arizona Monitoring

Urban haze studies were conducted in Phoenix 1989-90 and in Tucson in 1992-93. Each of those recommended long-term monitoring of visibility as a priority, which ADEQ began in 1993. ADEQ utilizes an array of instrumentation in each of the urban areas, including aerosol sampling, measurements of light scattering and light extinction, and video. All of those activities continue in 1998, and are being integrated into the $PM_{2.5}$ sampling effort.

More recently, in anticipation of the regional haze rule, ADEQ undertook development of a visibility monitoring program directed at Class I areas in partnership with Arizona's federal land managers. The aim is to collect data at all of Arizona's Class I areas too most effectively develop a SIP. Based on the draft regional haze rule, five years of data will be needed. Initially, the intent was to put in at least eight sites to fill in the gaps in the existing IMPROVE network. Due to the pending expansion of IMPROVE, ADEQ is modifying its plan to a more integrated approach. Since the IMPROVE program consists only of aerosol sampling, ADEQ will often jointly operate sites by installing nephelometers that measure light scattering. Since IMPROVE aerosol samplers will only operate every three days and represent twenty-four hour averages, making continuous measurements provides insight into variation in visibility impairment with time, along with advancing the understanding of the relationship between particles and light scattering. **Map A-1** shows the location of ADEQ's Class I monitoring sites.

NOGALES AIR QUALITY STUDY

The Ambos Nogales *(Nogales, Arizona and Nogales, Sonora)* Project, funded by EPA, commenced in early 1994 and was completed in 1999. Pioneering in scope at a binational level, the study was designed to determine the effects on human health of emissions and atmospheric transport of hazardous air pollutants *(HAPS)* and particulate matter *(PM)*. HAPS is a set of diverse and complex compounds that spans a broad range of chemical and physical properties that have particularly detrimental health effects.

Comprehensive data and information gathering efforts included air sample collection, meteorological monitoring, air emissions inventories, atmospheric simulation modeling, and human health risk assessments.

The principal findings of the study are that the larger Mexican portion of the area is the predominant source of emissions, and that PM from traffic on paved and unpaved roads causes the highest health risk to the public on both sides of the border. Typical exposure to PM potentially increases asthma episodes and adverse lower respiratory effects by as much as 8 percent on both sides of the border, and increases premature deaths from cardiovascular and respiratory causes by as much as 4 percent and 11 percent, respectively.

DOUGLAS / AGUA PRIETA AIR QUALITY STUDY

A similar study is just getting started in 1999 in Douglas, Arizona and Agua Prieta, Sonora, Mexico. Air quality questions were raised by ADEQ and Mexico's Secretaria de Medio Ambiente, Recursos Naturales y Pesca that led to the work being funded by EPA. As with Nogales, the project consists of ambient monitoring, emission inventory, air quality modeling, and health risk assessment.

The first part, ambient monitoring, is being conducted during 1999 at several sites in the area, which are identified in map A-6. Both PM and HAPS are being monitored every sixth day for a year, along with continuous measurements of carbon monoxide. In addition to characterizing ambient concentrations, meteorological monitoring is being conducted to be able to represent transport of pollutants in the air quality modeling. This includes both surface and aboveground measurements. The aboveground measurements are with a radar wind profiler at the Douglas Municipal Airport. Emissions information will also be collected during 1999 to compliment the ambient data, both of which are needed for modeling. Once the air quality modeling is completed and concentrations of PM and HAPS are estimated, an assessment of the health risk will be undertaken.

DEPARTMENT OF ENERGY PHOENIX OZONE STUDY

In May and June of 1998 in Phoenix, staff from the Brookhaven National Laboratory led staff from other national laboratories and the

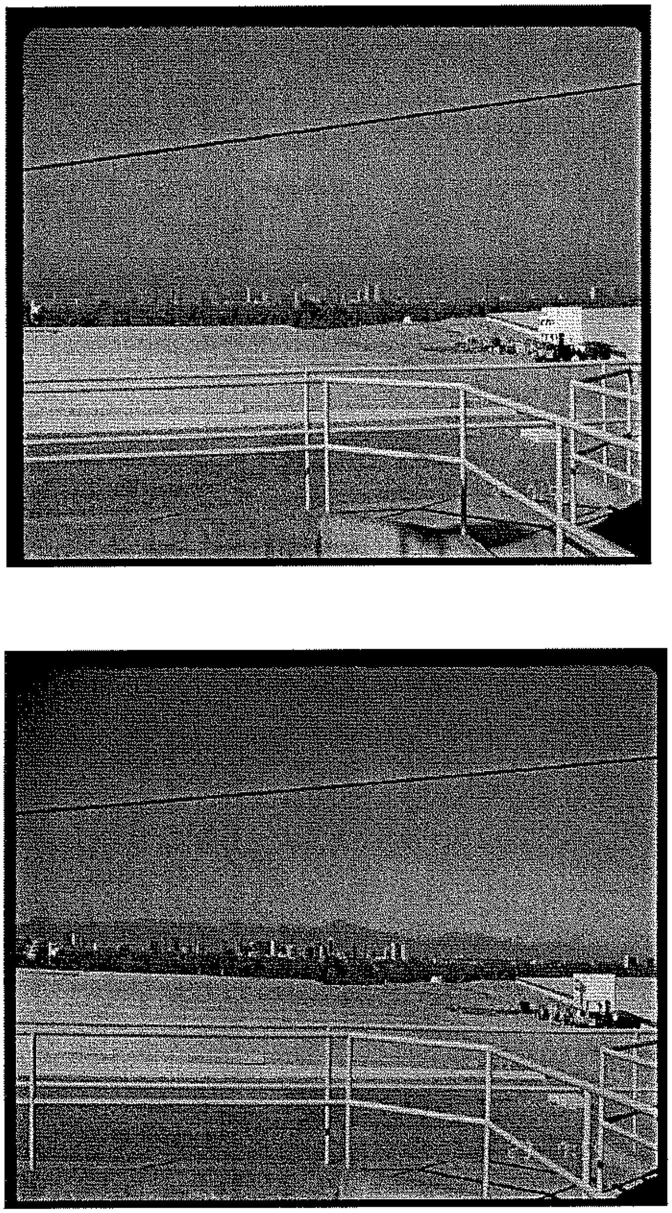
ADEQ in an intensive study of ozone, its precursors, and its reaction products. ADEQ staff deployed additional continuous monitors in support of the study, collected and analyzed samples of volatile organic compounds at four sites, and assisted the visiting staff in numerous logistical and scientific aspects of the project. The Department of Energy aircraft — equipped with a wide variety of standard and exotic air pollution monitors — obtained the first measurements of ozone aloft in Phoenix. Several exotic photochemical precursors and byproducts of ozone were measured for the first time in Arizona both aloft and at the surface. Ground-based instruments recorded the first continuous measurements of winds and temperatures aloft in Phoenix. The study provided a wealth of information about the photochemistry of the Phoenix airshed that will be published in scientific journals and that will greatly aid all atmospheric modeling of the airshed.

METEOROLOGICAL NETWORK

Almost every air quality monitoring site in Arizona has one or more pieces of meteorological equipment. This equipment may include sensors for recording wind direction and speed, which aid in understanding pollution dispersion patterns. Barometric pressure, temperature, and relative humidity are also measured at some sites and provide information about the character of the air mass at that location. These variables are measured on an hourly basis using barometers and temperature and relative humidity sensors. A few sites have temperature measurements at two levels to measure vertical temperature changes near the earth's surface. These measurements provide information about temperature inversions. Solar radiation sensors will be added to some sites in the ADEQ network in 1999 to assist in understanding the energy balance of the atmosphere and its impact on pollution patterns.

Meteorological measurements are also used to determine the impact of weather on air pollution events. High wind conditions associated with summer thunderstorms or wintertime cold front passages may stir up dust and dirt and cause high PM readings. Visibility changes can be associated with wind events and tracked as they move across the state when light scattering and extinction measurements are examined with meteorological data. No meteorological data are included in this report; however, **Appendix A** lists the meteorological monitoring equipment located at air quality sites. ●

PART IV
TRENDS



Dirty *(upper)* and Clean *(lower)* Views of Phoenix

PART IV - TRENDS

INTRODUCTION

Whether air quality meets the standards is an important question, but one posed more often is whether the air quality is improving or deteriorating. In Arizona, because of the phasing out of leaded gasoline in the mid-1970s and the installation of effective controls on copper smelters in the 1980s, the concentrations of both lead and sulfur dioxide decreased rapidly. Although improvements have also been made in the concentrations of carbon monoxide, ozone, and particulates, the last two still exceed air quality standards at some sites: the eight-hour ozone standard at several sites in greater Phoenix and the 24-hour and annual PM_{10} standards at a few rural sites. Visibility — the aspect of the urban atmosphere that is most obvious to the population — is measured continuously in Tucson and Phoenix. This discussion examines the trends in these three common air pollutants throughout Arizona and the urban visibility trends.

CARBON MONOXIDE

Since the mid to late 1970s, carbon monoxide concentrations have declined as much as two-thirds. In Tucson, the maximum annual eight-hour concentration of carbon monoxide at 22nd Street and Alvernon declined from 12 to 4 parts per million *(ppm)*. In Phoenix at 18th Street and Roosevelt *(Central Phoenix)*, the decline was from 23.0 to 7.1 ppm ***(Figures IV-1 and IV-2)***. The number of exceedances of the eight-hour standard — 9 ppm — in Phoenix decreased from 75 to 0 at Central Phoenix. The entire Phoenix network of carbon monoxide monitors recorded over 100 exceedances each year from 1981 through 1986, with an average of 134 per year. No exceedances were recorded by this network in 1997 and 1998. Most of this improvement can be attributed to Federal new-vehicle emission standards, augmented by emission reductions from the Vehicle Inspection and Maintenance Program, which began in 1976, and the use of oxygenated fuels in the winter, beginning in 1989.

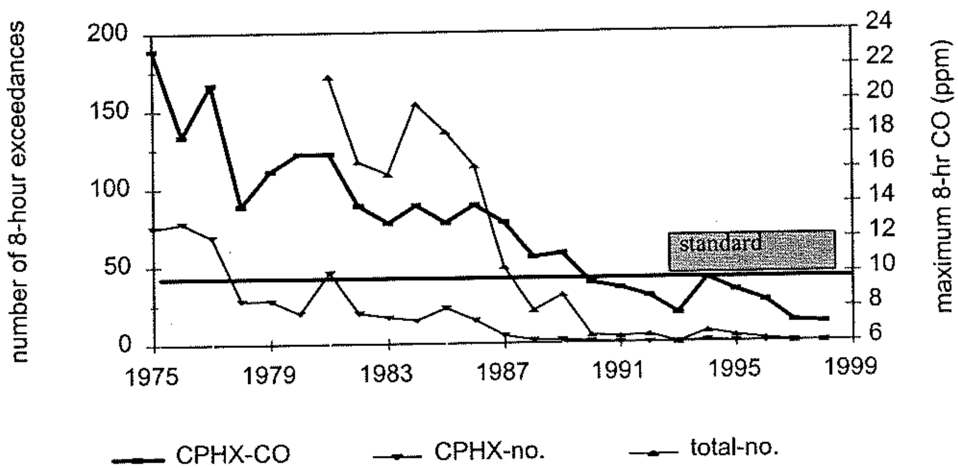


Figure IV-1 Eight-hour carbon monoxide concentrations at Central Phoenix *(CPHX)*, with the number of exceedances at CPHX and in the entire network

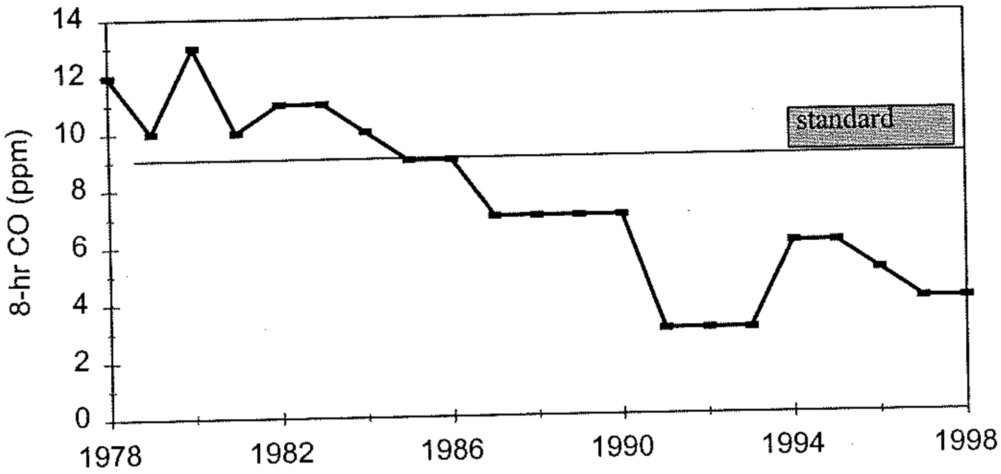


Figure IV-2 Eight-hour carbon monoxide maxima at 22nd Street and Alvernon Way in Tucson

OZONE

One-hour ozone concentrations

Maximum one-hour average ozone concentrations have remained steady in Tucson and Yuma, but have declined in Phoenix since 1980 (***Figure** IV-3*). The Phoenix decrease in ozone concentrations has been nowhere near as pronounced as its declining carbon monoxide trend, but the net result has been the same: no exceedances of the standard were recorded in 1997 or 1998.

Because of its relatively high background level and its photochemical formation from hydrocarbons and nitrogen oxides, changes in emissions would not be expected to translate into proportional changes in concentration. Recent atmospheric modeling in Phoenix predicts that ozone concentrations should have remained constant from 1996 to 1999, but the decrease in measured ambient concentrations contradicts these predictions.

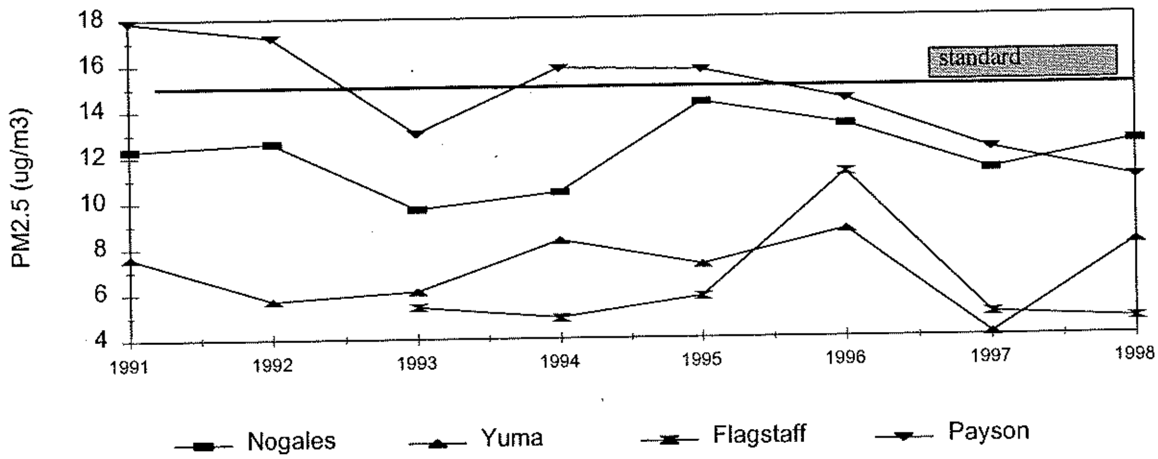


Figure IV-13 Statewide annual $PM_{2.5}$ concentrations

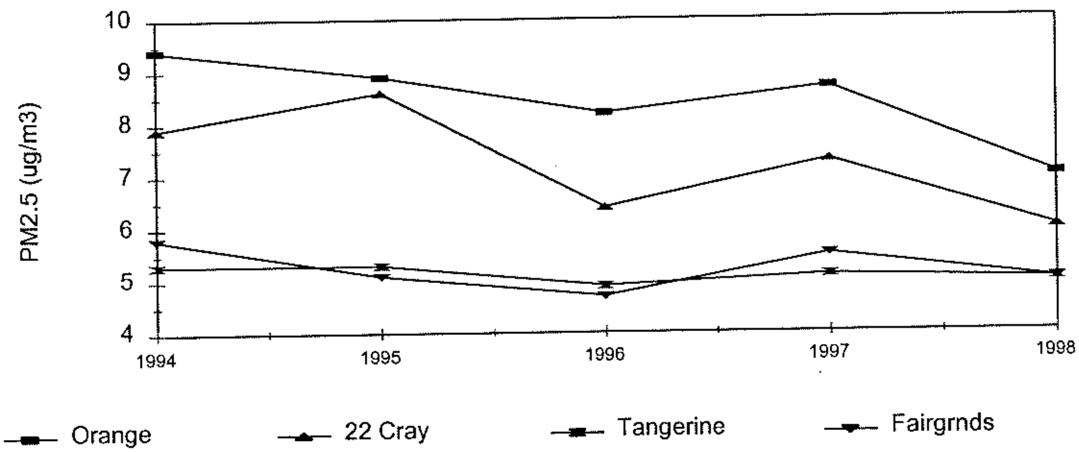


Figure IV-14 Annual $PM_{2.5}$ concentrations in Tucson

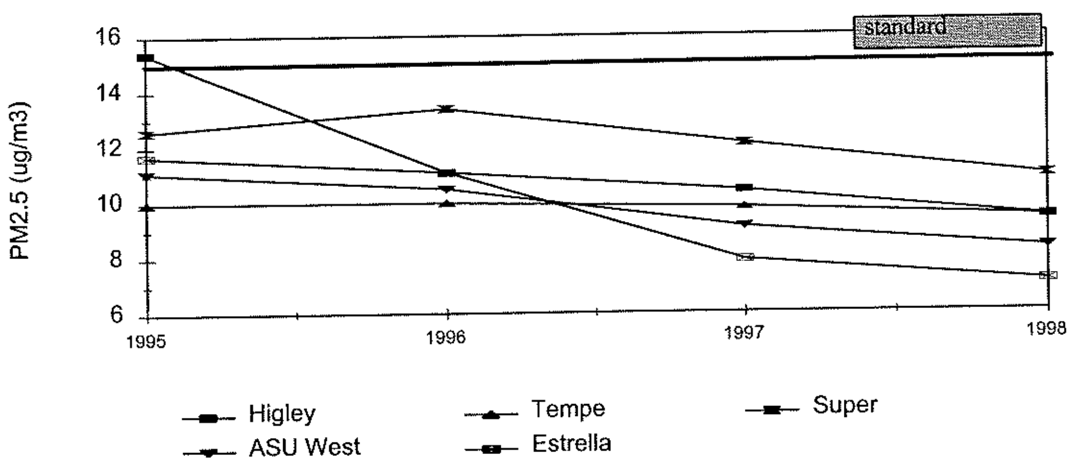


Figure IV-15 Annual $PM_{2.5}$ concentrations in Phoenix

VISIBILITY

Optical measurements of visibility have been made continuously since 1993 in Tucson and since 1994 in Phoenix. Light extinction — the degree to which sunlight is reduced by its interaction with fine particles and gases in the atmosphere — is measured continuously with transmissometers. These measurements have been divided into six categories: the mean of the dirtiest 20 percent of all hours, the mean of all hours, and the mean of the cleanest 20 percent of all hours — for both the entire day and the 5 - 11 a.m. period. **Table 3** and **Figures IV-16** and **IV-17** present these data.

Table IV-3 Light extinction in Phoenix and Tucson
(Units are inverse megameters (Mm^{-1}))

PHOENIX						
year	all hours			5-11a.m.		
	dirtiest 20%	mean	cleanest 20%	dirtiest 20%	mean	cleanest 20%
1994	123	63	28	129	70	33
1995	138	75	38	134	78	42
1996	133	78	44	129	80	45
1997	137	83	50	136	87	54
1998	144	88	54	148	94	60
% diff 94 to 98	+17.07	+39.68	+92.86	+14.73	+34.29	+81.82
annual %	+3.41	+7.94	+18.57	+2.95	+6.86	+16.36
TUCSON						
year	all hours			5-11 a.m.		
	dirtiest 20 %	mean	cleanest 20 %	dirtiest 20 %	mean	cleanest 20 %
1993	108	64	35	129	74	39
1994	92	58	35	110	68	40
1995	102	61	35	116	68	38
1996	104	65	39	116	73	43
1997	91	59	36	105	66	38
1998	103	57	28	121	69	34
% diff 93 to 98	-4.63	-10.94	-20.00	-6.20	-6.76	-12.82
annual percent	-0.93	-2.19	-4.00	-1.24	-1.35	-2.56

Note: The percentage difference between either 1993 or 1994 and 1998 is divided by the number of years to give the average annual percentage change.

Seasonal patterns also vary between the two cites, with the mean and dirtiest 20 percent of all hourly light extinction values in Phoenix showing more pronounced winter and fall maxima than the Tucson counterparts (***Figure IV-18***). Both cities show almost no seasonal variation in the cleanest 20 percent of all hours. The seasonal light extinction values in Phoenix are considerably higher than Tucson's: for the dirtiest 20 percent of all hours, 52 percent higher in winter, 19 percent higher in spring, 13 percent higher in summer, and 49 percent higher in fall. These measurements of the poorer visibility in Phoenix will come as no surprise to those Arizonans familiar with both airsheds.

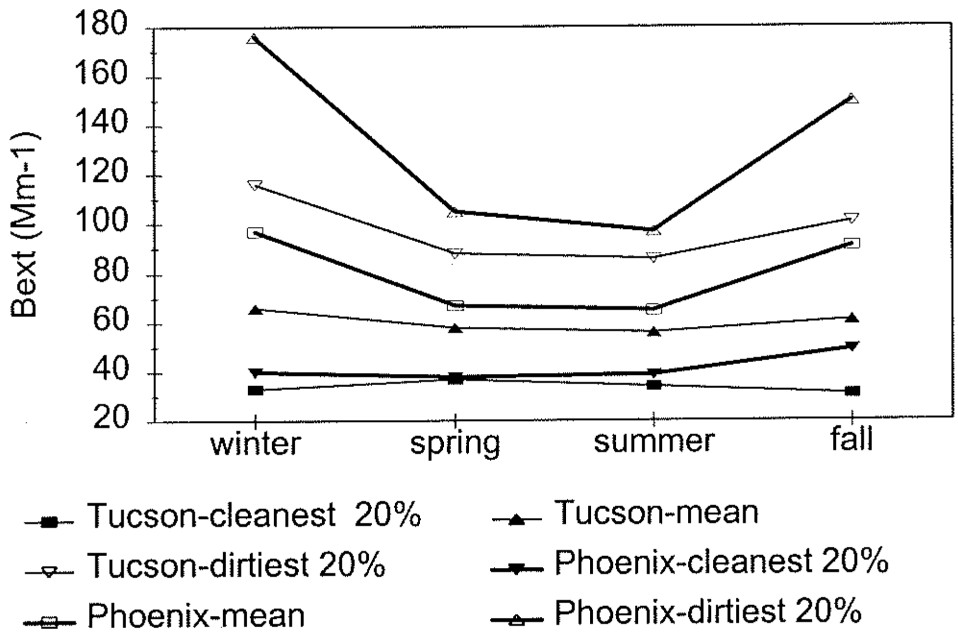


Figure IV-18 **Seasonal patterns of hourly light extinction in Tucson and Phoenix: 1993 - 1998**

Conclusions

Since monitoring of air pollutants began in the late 1960s in Arizona, considerable progress has been made in reducing concentrations of lead, sulfur dioxide, and carbon monoxide. Lead has been reduced to nearly background levels; sulfur dioxide concentrations near copper smelters, that chronically exceeded the standards until the mid-1980s, are now well within these standards; and carbon monoxide concentrations, that regularly exceeded standards in neighborhoods and near busy intersections in Phoenix *(and to a far lesser extent in Tucson)*, now meet the standards. One-hour ozone concentrations in Phoenix met the standard in 1997 and 1998, the first years since monitoring began. Phoenix ozone concentrations in the 1980s and early 1990s used to range as high as 0.15 to 0.18 parts per million *(the standard is 0.12 ppm)*, in contrast to the highest, most recent reading of 0.14 ppm in 1996. Twelve of 26 ozone monitoring sites in greater Phoenix still exceeded the new 8-hour ozone standard in 1996 - 1998, indicative that the general downward trend has not resulted in sufficiently clean air.

Elevated concentrations of particulate matter smaller than 10 microns *(PM_{10})* have been reduced substantially since the mid-1980s, with decreases of 20 to 70 percent in the urban areas and in most smaller cities and towns. In Payson and at some industrial sites, PM_{10} concentrations have been reduced by as much as two-thirds. By 1998, monitored violations of the PM_{10} standard — a once common occurrence at many sites only ten years ago — were limited to a few sites. Air quality in the vicinity of dense particulate emissions, however, continues to exceed standards even though it is not being monitored. Fine particulates concentrations *($PM_{2.5}$)* have decreased in Phoenix and Tucson since 1995 and 1994, respectively; for example, at the centrally located Phoenix Supersite, the decrease has been 21 percent; at 22nd and Craycroft, in east-central Tucson, the decrease has been 24 percent. The Phoenix decreases are inconsistent with the increasing trends in light extinction, caused primarily by small particles.

In spite of the continued growth in Arizona, with the exception of Phoenix visibility in the last five years, not a single air pollutant at any site shows a consistent upward trend. Most standards are met most of the time, with the exceptions being the 8-hour ozone standard in Phoenix summers and the PM_{10} standards on both an episodic and annual basis at those sites affected by localized dense emissions. These improving air quality trends, resulting from control programs at the federal, state, and local levels, have improved the respiratory health of the citizenry and can be considered a testament to the public support for a cleaner environment. •

APPENDIX

TABLE A-1
SITE INDEX

Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
1	7 Mile Store	South of Whiteriver	33° 47'	109° 57'	WMAT	PM10
2	Ajo	ADOT Well Rd.	32° 25'	112° 50'	ADEQ	PM10, Wind
3	Apache Junction	3955 E Superstition Blvd-TE	33° 25'	111° 30'	PCAQCD	PM2.5
4	Apache Junction Highway Yard	SW Corner Hwy 88 and Superstition Rd.	33° 25'	111° 32'	PCAQD	PM10, O3, CO, MET
5	Blue Point	Sheriff's Office, Maricopa County	33° 33'	111° 36'	MCESD	O3
6	Bullhead City - ADEQ	990 Highway 95	35° 05'	114° 35'	ADEQ	PM10, PM2.5
7	Bullhead City - Alonas Way	1285 Alonas Way, Bullhead City	35° 07'	114° 35'	SCE	NOX, PM10
8	Casa Grande Airport	660 W. Aero Drive	32° 54'	111° 46	PCAQCD	O3, CO, MET
9	Casa Grande - County Fairgrounds *(EMC)*	Eleven-Mile Corner Road, south of SR 287	32° 52'	111° 34	PCAQCD	PM10
10	Casa Grande DES	401 Marshall Rd.	32° 52'	111° 45'	PCAQCD	PM2.5, PM10
11	Central Phoenix	1845 E. Roosevelt	33° 27'	111° 02'	MCESD	PM10, CO, NO2, O3
12	Chandler	1475 E. Pecos Rd.	33° 17'	111° 49'	MCESD	O3, PM10
13	Chiricahua National Monument	Faraway Ranch	32° 00'	109° 23'	NPS	IMPROVE
14	Clarkdale -ADEQ	School, 1615 Main Street	34° 46'	112:03	ADEQ	PM10, PM2.5
15	Clarkdale - NW	NW of Cement Plant	34° 45'	112° 05'	PCC	PM10, PM2.5, Lead
16	Clarkdale - SE	SE of CTI Flyash Silo	34° 45'	112° 05'	PCC	PM10, PM2.5, Lead
17	Claypool	Cyprus Miami	33° 24'	110° 52'	CMMC	PM10
18	Coolidge	NE Corner of Pacific St. and Broadway	32° 58'	111° 30'	PCAQCD	PM10
19	Coronado	Generating Station, 6 mi NE St. Johns	34° 35'	112° 03'	SRP	NOX, O3, PM10
20	Douglas - Red Cross	1445-1449 15th Street Record begins Sept. 1998	31° 20'	109° 30'	ADEQ	PM10, PM2.5, Lead

TABLE A-1 (CONT'D)
SITE INDEX

Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
21	Douglas - High School	High School Record ends June 1998	31° 20'	109° 30'	ADEQ	PM10, PM2.5
22	Eloy	620 N. Main Street	32° 45'	111° 33'	PCAQCD	PM10
23	Estrella	15099 W Casey Abbott Dr., Goodyear	33° 23'	112° 22'	ADEQ	PM10, PM2.5
24	Flagstaff - ADOT	ADOT Yard, 5701 E. Railroad Ave.	35° 12'	111° 37'	ADEQ	PM10
25	Flagstaff - Middle School	Middle School, 755 N. Bonito	35° 12'	111° 38'	ADEQ	PM10, PM2.5
26	Fort Mohave	2230 Joy Lane	34° 51'	114° 35'	ADEQ	PM10, PM2.5
27	Fountain Hills	16426 E. Palisades	33° 37'	111° 43'	MCESD	O3
28	Gilbert	535 N. Lindsay Road	33° 22'	111° 46'	MCESD	PM10, CO
29	Glendale	6000 W. Olive	33° 33'	112° 12'	MCESD	PM10, CO, O3
30	Grand Canyon National Park - Hopi Point	Near Hopi fire tower	36° 04'	112° 09'	NPS	IMPROVE
31	Grand Canyon National Park - Airport	Airport	35° 57'	112° 09'	ADEQ	PM10, Bscat, Wind
32	Green Valley - ADEQ	7515 W. Magee Ranch Rd. *(Sierrita, Elam Ranch)*	31° 54'	111° 10'	ADEQ	SO2
33	Green Valley - PDEQ	245 W. Esperanza	31° 52'	110° 59'	PDEQ	PM10
34	Hayden - Old Jail	Jail on Canyon Dr.	33° 00'	110° 47'	ADEQ	SO2, PM10, Lead
35	Hayden - Garfield Ave.	Garfield Ave.	33° 00'	110° 47'	ASARCO	SO2
36	Hayden - Junction	Junction	33° 00'	110° 50'	ASARCO	SO2
37	Hayden - Montgomery Ranch	Montgomery Ranch	33° 00'	110° 47'	ASARCO	SO2
38	Hayden - Old Jail	Jail on Canyon Dr.	33° 00'	110° 47'	ASARCO	SO2
39	Higley	15500 S. Higley Rd.	33° 18'	111° 43'	ADEQ	PM10, PM2.5

TABLE A-1 *(CONT'D)*
SITE INDEX

Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
40	Hillside	Sheriff's Repeater Station	34° 25'	112° 54'	ADEQ	O3, PM10, PM2.5
41	Humboldt Mountain	Tonto National Forest	33° 59'	111° 47'	MCESD / ADEQ	O3, Bscat, MET
42	Joseph City - APS	Cholla Generating Station	34° 57'	110° 20'	APS	PM10
43	Joseph City - APS	Third and Tanner	34° 57'	110° 18'	APS	PM10
44	Kingman- Praxair	I-40 and Griffith Rd.	35° 00'	114° 08'	Praxair	PM10
45	Lake Pleasant	Lake Pleasant	33° 51'	112° 19'	MCESD	O3
46	Mammoth	4 th Street and Corona			PCAQCD	PM10
47	Maricopa	Trading Post and San Lorenzo Dr.	32° 59'	111° 55'	PCAQCD	PM10
48	McFadden	McFadden Peak, Sierra Ancha Wilderness	33° 53'	110° 58'	ADEQ	Bscat, MET
49	Mesa	370 S. Brooks *(N. of Broadway)*	33° 24'	111° 51'	MCESD	O3, PM10,Wind, CO,Pressure, PM10
50	Mesa - Falcon Field	4530 E Mckellips, Mesa	33° 27'	112° 04'	MCESD	O3, Wind
51	Miami -ADEQ Ridgeline	Ridgeline - 4030 Linden St.	33° 23'	110° 52'	ADEQ	SO2
52	Miami - Golf Course	Golf Course	33° 23'	110° 52'	CMMC	PM10, PM2.5
53	Miami - Ridgeline	Ridgeline	33° 23'	110° 52'	CMMC	PM10, PM2.5
54	Montezuma Castle National Monument	3 miles NNE, Camp Verde	34° 35'	111° 49'	ADEQ	PM2.5, PM10, Lead
55	Mt. Ord - ADEQ	Mazatzal Mountains	33° 55'	111° 25'	ADEQ	PM2.5, Bscat
56	Mt. Ord - MCESD	Mazatzal Mountains	33° 55'	111° 25'	ADEQ	O3, Wind
57	Mt. Ord - NPS	Mazatzal Mountains	33° 55'	111° 25'	ADEQ	IMPROVE
58	Muleshoe Ranch	Muleshoe Ranch Preserve	32° 21'	110° 14'	ADEQ	Bscat, MET
59	Naco		31° 20'	109° 57'	ADEQ	PM10
60	Nelson	1 mile North, Flintkote Lime Plant	35° 34'	113°15'	ADEQ	PM10, PM2.5

TABLE A-1 (CONT'D)
SITE INDEX

Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
61	Nogales	300 N. Morley Ave	31° 21'	110° 57'	ADEQ	PM10, PM2.5, Lead
62	North Phoenix	601 E. Butler	33°33'	112°04'	MCESD	O3, PM10 , CO
63	Orange Grove	3401 W. Orange Grove Rd.	32°19'	110°02'	PDEQ/ADEQ	PM10, PM2.5
64	Organ Pipe Cactus National Monument	1 mi SSW Visitor Center	31° 58'	112° 48'	ADEQ	PM10, PM2.5, Lead
65	Page	Navajo Generating Station, 3 miles East of Page	36° 55'	111° 24'	SRP	NOX, O3, PM10
66	Palo Verde	36248 W. Elliot Rd.	33° 20'	112° 50'	ADEQ	NOX, O3, PM10, PM2.5
67	Paul Spur	Naco Rd.	31° 22'	109° 44'	ADEQ	Wind, PM10, PM2.5
68	Payson	204 W. Aero Dr.	34° 14'	111° 20'	ADEQ	PM10, PM2.5
69	Petrified Forest National Park	1 mi. N. Park Headquarters	35° 05'	109° 48'	NPS	IMPROVE
70	Phoenix-ASU West	4701 W. Thunderbird Rd.	33° 36'	112° 09'	ADEQ	PM10, PM2.5
71	Phoenix - Bank One	201 N. Central	33° 15'	112° 02'	ADEQ	Temp
72	Phoenix-Desert Recreation Center	2602 N. 23rd Ave.	na	na	ADEQ	PM2.5
73	Phoenix - Emergency Management	2035 N. 52nd St.	33° 26'	111° :57'	MCESD	O3
74	Phoenix-Grand Avenue	Grand / 27 Ave./Thomas	33° 28'	112° 07'	ADEQ	CO
75	Phoenix - Greenwood - ADEQ	I-10 and 27th Avenue	33° 28'	112° 07'	ADEQ	PM10, Lead
76	Phoenix - Greenwood - MCESD	I-10 and 27th Avenue, Phoenix	33° 28'	112° 07'	MCESD	PM10, CO, NO
77	Phoenix - JLG Super Site	4530 N. 17 Ave.	33° 30'	112° 05'	ADEQ	CO, NOX, O3, Met, PM10, PM2.5

TABLE A-1 *(CONT'D)*
SITE INDEX

Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
78	Phoenix-Magnet Traditional	2602 N. 23 Ave.	na	na	ADEQ	PM2.5
79	Phoenix - Maryvale	6180 W. Encanto	33° 28'	112° 20'	MCESD	O3, CO, Pressure, PM10
80	Phoenix Post Office	3905 N. 7th Ave.	na	na	ADEQ	CO
81	Phoenix - Salt River	3045 S. 22nd Ave.	33° 21'	112° 06'	MCESD	PM10
82	Phoenix-Transmiss-ometer	Phx Baptist Hosp. To Quality Hotel	na	na	ADEQ	Bext
83	Phoenix - Vehicle Emissions	600 N. 40th St.	33° 27'	112° 00'	ADEQ	
84	Phoenix - West Indian Sch.	W Indian School / 75 Ave., Phoenix	33°30'	112° 08'	MCESD	CO
85	Pinal Air Park	Between Red Rock and Marana at the Number 2 Water Well	32° 31'	111° 20'	PCAQCD	PM10
86	Pinnacle Peak	25000 N Windy Walk, Scottsdale	33° 42'	111° 51'	MCESD	O3
87	Prescott	22 S. Cortez	34° 32'	112° 28'	ADEQ	PM10
88	Rillito - ADEQ	8820 W. Water	32° 25'	111° 10'	ADEQ	PM10
89	Rillito - APCC	8820 W. Water	32° 27'	110° 09'	APCC	PM10
90	Rio Verde	25608 N. Forest Rd., MCSD Substation	33° 43'	111° 40'	MCESD	O3
91	Rucker Canyon	Chiricahua National Forest	31° 47'	109° 18'	ADEQ	Bscat, MET
92	Rye		34° 06'	111° 22'	ADEQ	O3, MET
93	Safford	523 Tenth Ave.	32° 49	109° 43'	ADEQ	PM10
94	Saguaro NP - West Unit	West Unit Maintenance	32° 17'	111° 10'	ADEQ	PM2.5
95	Saguaro Park	South Old Spanish Trail, Saguaro Natl. Park, East Unit	32° 10'	110° 44'	PDEQ	O3
96	Saguaro National Monument				NPS	IMPROVE

TABLE A-1 *(CONT'D)*
SITE INDEX

Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
97	St. Johns	Carrizo Draw	34° 37'	109° 25'	SRP	PM10, PM2.5, NOX
98	St. Johns	Mesa Parada	34° 35'	109° 25'	SRP	PM10, PM2.5, O3, NOX
99	Salt River Pima - Maricopa	10005 E. Osborn, Phoenix	33° 30'	111° 50'	ADEQ	NOX, O3
100	San Manuel	First and Douglas Ave.	32° 36'	111° 63'	ADEQ	SO2
101	San Manuel	Townsite	32° 36'	111° 63'	BHP	SO2
102	San Manuel	Dorm site	32° 36'	111° 63'	BHP	SO2
103	San Manuel	Hospital	32° 36'	111° 63'	BHP	SO2
104	Sedona	Post Office	34° 52'	111° 45'	ADEQ	PM10
105	Show Low	Deuce of Clubs Ave.	34° 15'	110° 02'	ADEQ	PM10
106	South Phoenix	4732 S. Central	33° 24'	112° 04'	MCESD	PM10, CO, O3
107	South Scottsdale	2857 N. Miller	33° 28'	111° 55'	MCESD	NOX, O3, PM10, CO
108	South Tucson	1810 S. 6 Ave.	32° 12'	110° 58'	PDEQ/ADEQ	PM10
109	Springerville	15 mi NE Springerville	34° 19'	109° 10'	TEP	NOX, PM10, PM2.5
110	Springerville	Coyote Hills	34° 15'	109° 15'	TEP	PM2.5, NOX, PM10
111	Stanfield	36697 W. Papago Drive	32° 53'	111° 57	PCAQCD	PM10
112	Sycamore Canyon	Camp Raymond	35° 02'	111° 59'	ADEQ	Bscat, MET
113	Tempe	3340 S. Rural Rd.	33° 23'	111° 55'	ADEQ	PM10, PM2.5
114	Tonto National Monument	Maintenance Station	33° 39'	111° 07'	NPS	IMPROVE
115	Tucson - Alvernon	near 22nd Ave. / Alvernon	32° 12'	110° 54'	PDEQ	CO
116	Tucson - Broadway / Swan	4625 E. Broadway	32° 13'	110° 53'	PDEQ	PM10
117	Tucson - Cherry	2745 N. Cherry	32° 15'	110° 56'	PDEQ	
118	Tucson - Childrens Park	400 W. River Road	32° 17'	110° 58'	PDEQ	O3, PM2.5*
119	Tucson Convention Center	260 S. Church Ave.	32° 13'	110° 58'	PDEQ	

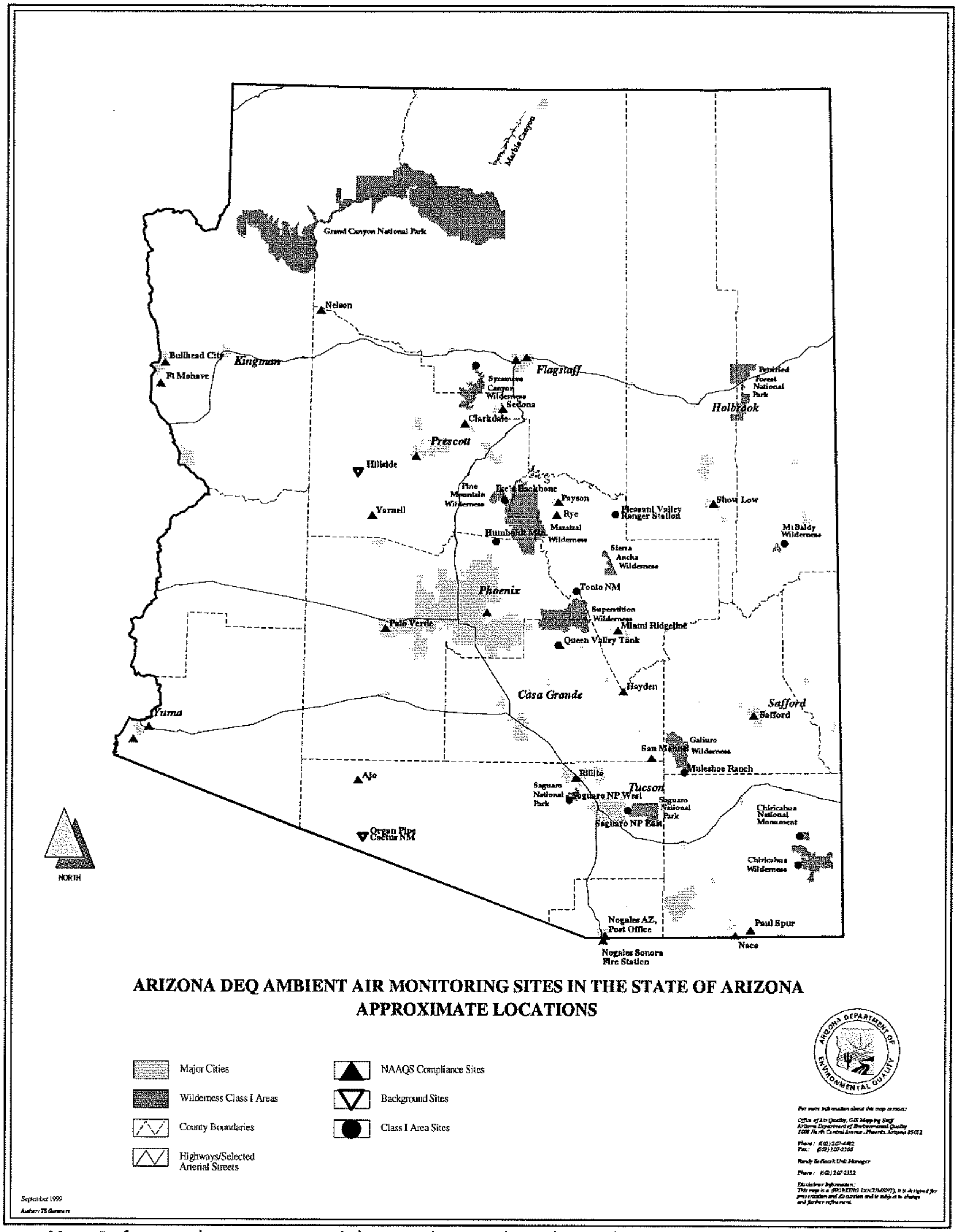
Site ID	Site Name	Site Address	Latitude	Longitude	Site operator	Measured
120	Tucson - Corona De Tucson	22000 S. Houghton Rd .	32° 00'	110° 47'	PDEQ	PM10
121	Tucson - Craycroft	near 22 Ave. / Craycroft	32° 12'	110° 52'	PDEQ	PM10, PM2.5, CO, NOX, O3
122	Tucson - Downtown	151 W. Congress	32° 13'	110° 58'	PDEQ	O3, CO, PM10
123	Tucson - Fairgrounds	11330 S. Houghton	32° 02'	110° 46'	PDEQ	O3, PM10
124	Tucson Mountain	Saguro National Park - West Unit	32° 17'	111° 10'	ADEQ	PM2.5, Bscat
125	Tucson - Orange Grove	3401 W. Orange Grove Rd.	32° 19'	111° 02'	PDEQ/ADEQ	PM2.5, PM10
126	Tucson -Prince Road	1016 W. Prince Rd.	32° 16'	110° 59'	PDEQ	PM10
127	Tucson - Sabino	4829 N. Sabino Canyon Rd.	32° 17'	110° 49'	PDEQ	
128	Tucson - Santa Clara	6910 S. Santa Clara Ave.	32° 07'	110° 58'	PDEQ	
129	Tucson - Tangerine	12101 N. Camino De Oeste, Tucson	32° 25'	110° 04'	PDEQ	PM10, O3, PM10
130	Tucson Transmiss-ometer	U of A Clinical Sci. To Pima DEQ	32° 13'	110° 57'	PDEQ/ADEQ	Bext
131	Tucson - U of A Central	1100 N. Fremont Ave	32° 13'	110° 57'	PDEQ/ADEQ	PM10, PM2.5, Bscat
132	Tusayan	Grand Canyon Airport	35° 57'	111° 59'	ADEQ	PM10, PM2.5
133	West Chandler	163 S. Price Rd.	33° 18'	111° 53'	MCESD	PM10, CO, O3
134	West Phoenix	3847 W. Earll	33° 29'	112° 08'	MCESD	CO, O3, PM10, NOX
135	Wickenburg	155 N. Tegner St.	33° 59'	112° 44'	MCESD	PM10
136	Yarnell	17175 Sunrise Road	34° 13'	112° 45'	ADEQ	PM10
137	Yuma	AZ Western College	32° 40'	114° 38'	ADEQ	O3
138	Yuma	Juvenile Center, 2795 Ave. B			ADEQ	PM10, PM2

Site Index Table Abbreviations And Notes

ADEQ	Arizona Department of Environmental Quality
APCC	Arizona Portland Cement Co.
APS	Arizona Public Service
ASARCO	ASARCO, Inc.
Bext	Total light extinction
Bscat	Light scattering
BHP	BHP Copper, Inc.
CMMC	Cyprus Miami Mining Co.
CO	Carbon Monoxide
IMPROVE	Interagency Monitoring of Protected Visual Environments
MCESD	Maricopa County Environmental Services Dept.
MET	Meteorological measurements *(wind, temperature, relative humidity)*
NOX	Nitrogen oxides
O3	Ozone
PCC	Phoenix Cement Company
PDEQ	Pima County Department of Environmental Quality
PCAQCD	Pinal County Air Quality Control Division
$PM_{2.5}$	Particulate matter < 2.5 microns
PM_{10}	Particulate matter < 10 microns
SCE	Southern California Edison
SRP	Salt River Project
TEP	Tucson Electric Power
USFS	U.S. Forest Service
Wind	Wind speed and direction
WMAT	White Mountain Apache Tribe

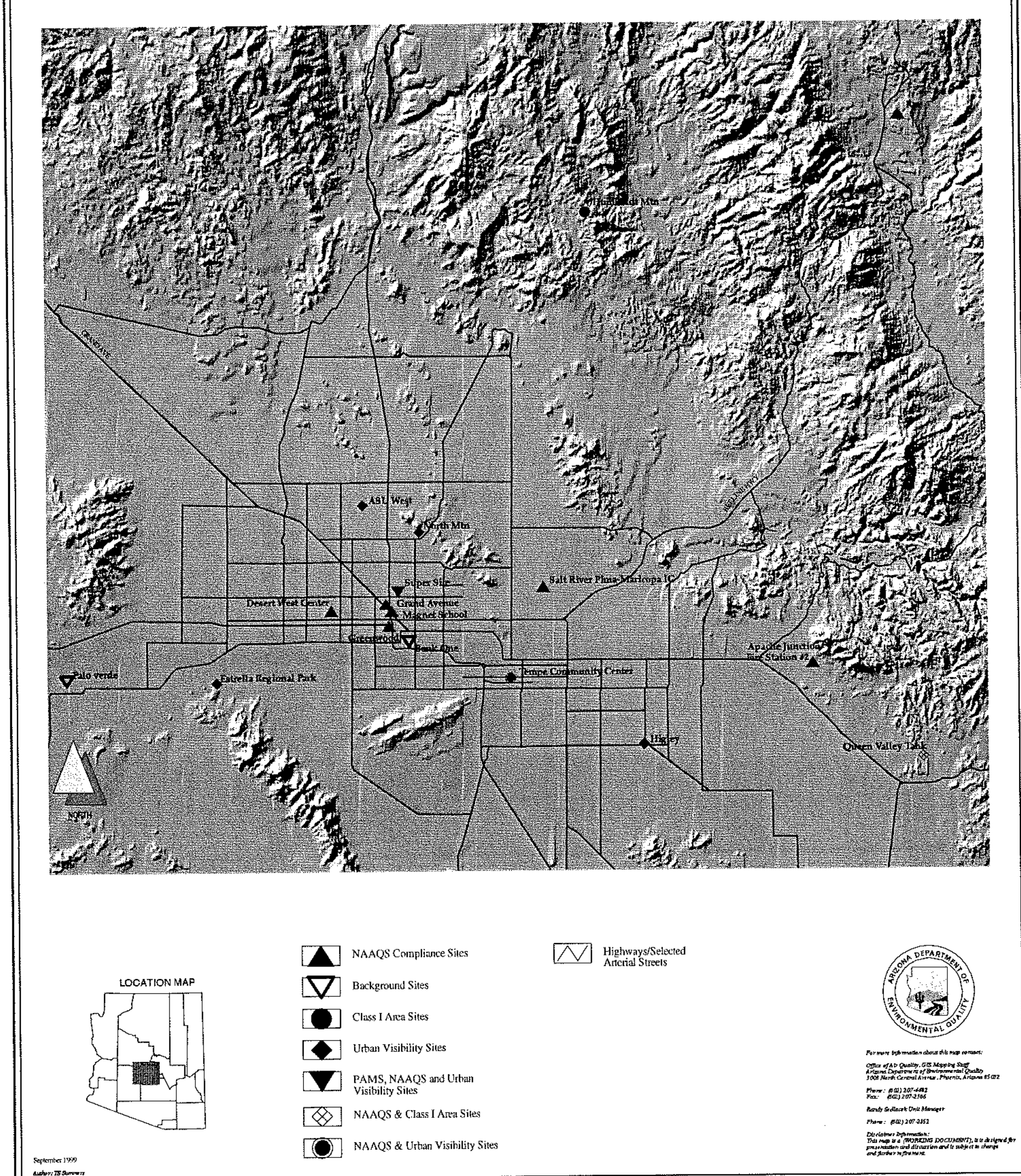
Notes:

Sites shown in the Site Index table are based on the best information available at the date of publication. All site information will be verified for inclusion in the next Annual Report.



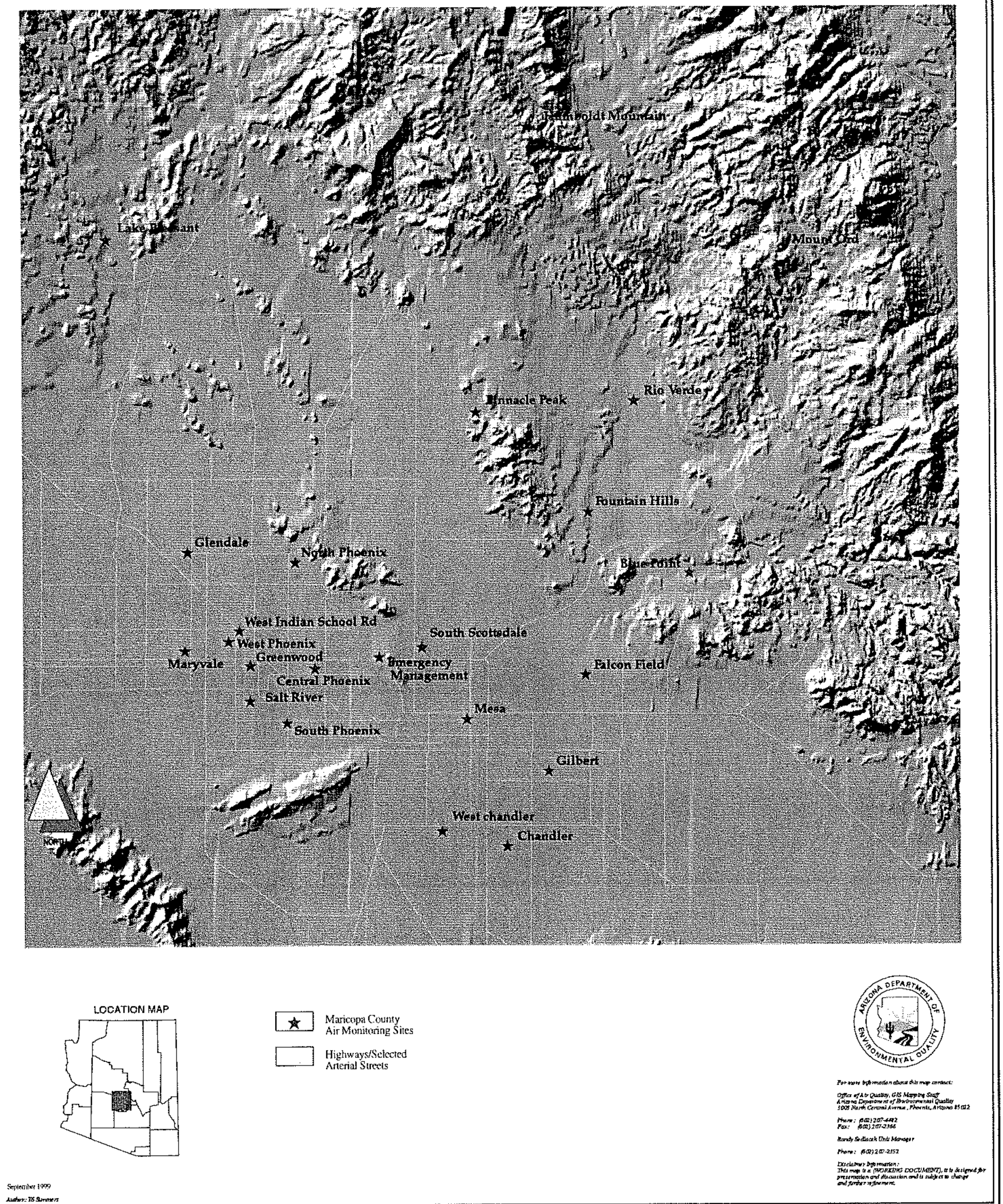
Map A-1 - Arizona DEQ Ambient Air Monitoring Sites in the Phoenix Area

ADEQ AMBIENT AIR MONITORING SITES IN THE PHOENIX AREA
APPROXIMATE LOCATIONS



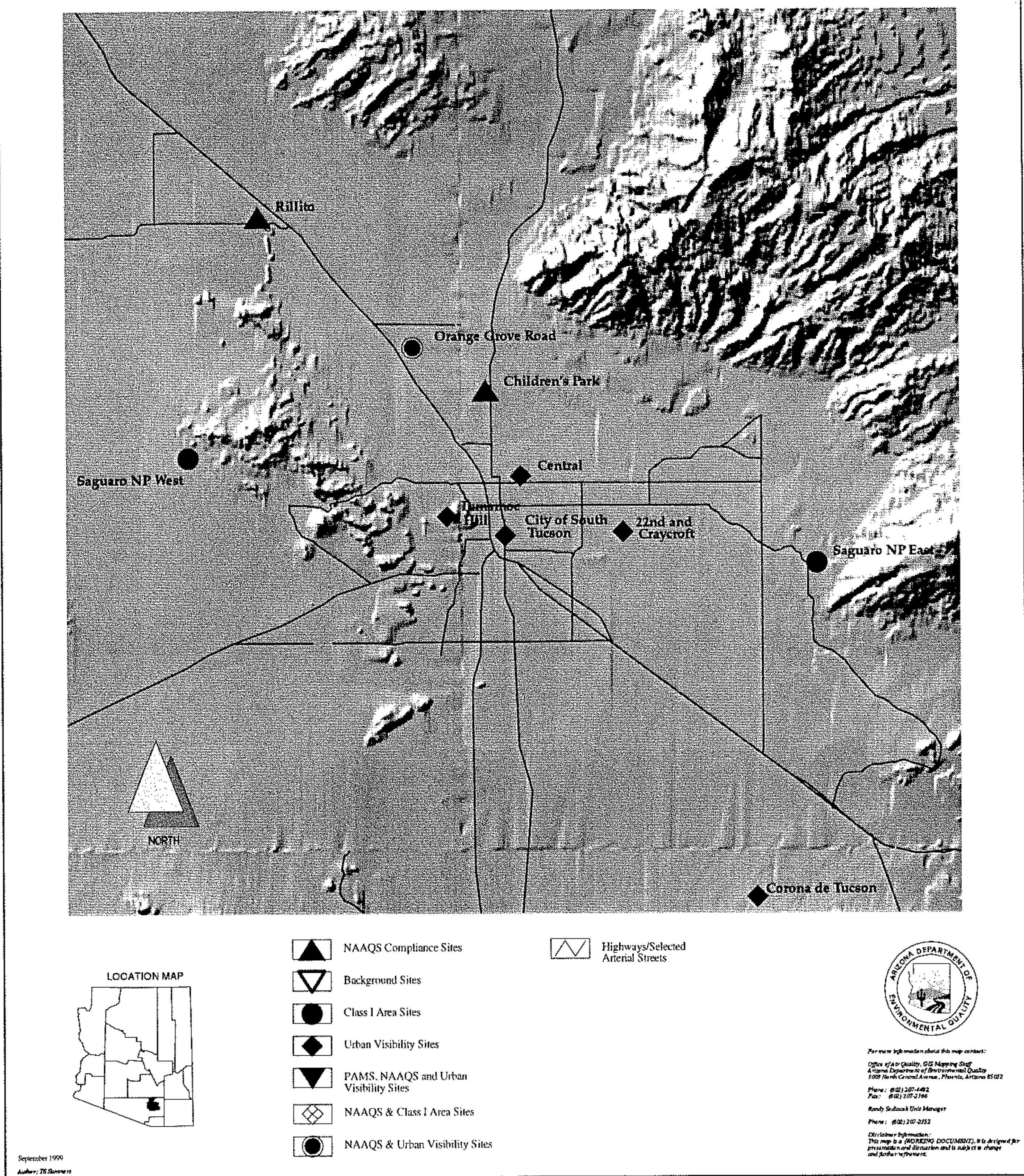
Map A-2 - Arizona DEQ Ambient Air Monitoring Sites in the Phoenix Area

MARICOPA COUNTY AMBIENT AIR MONITORING SITES
APPROXIMATE LOCATIONS



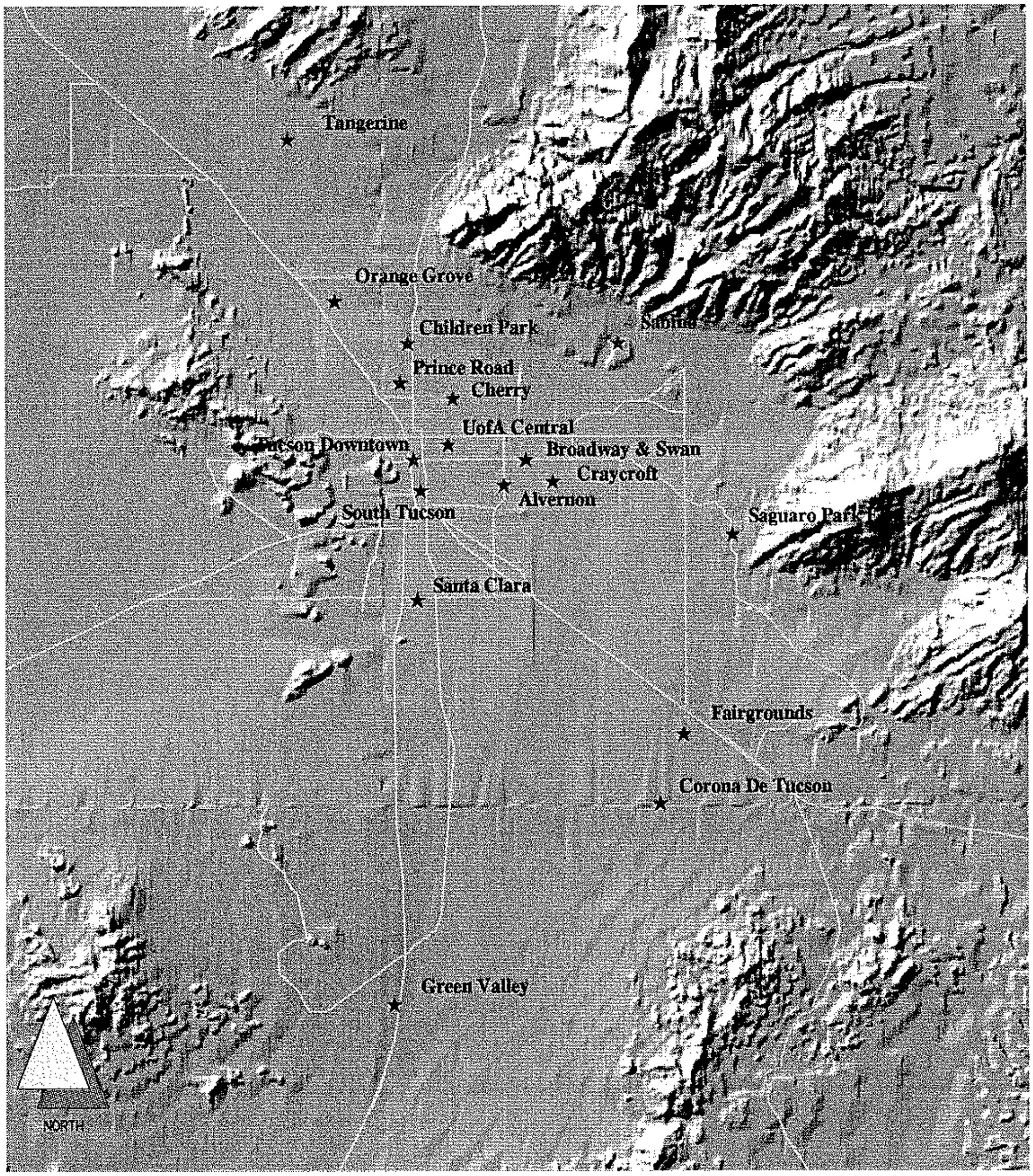
Map A-3 - Maricopa County Ambient Air Monitoring Sites

ADEQ AMBIENT AIR MONITORING SITES IN THE TUCSON AREA
APPROXIMATE LOCATIONS

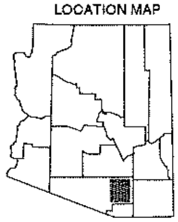


Map A-4 - Arizona DEQ Ambient Air Monitoring Sites in the Tucson Area

PIMA COUNTY DEQ AMBIENT AIR MONITORING SITES



LOCATION MAP



★	Pima County Air Monitoring Sites
	Highways/Selected Arterial Streets

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Disclaimer Information:
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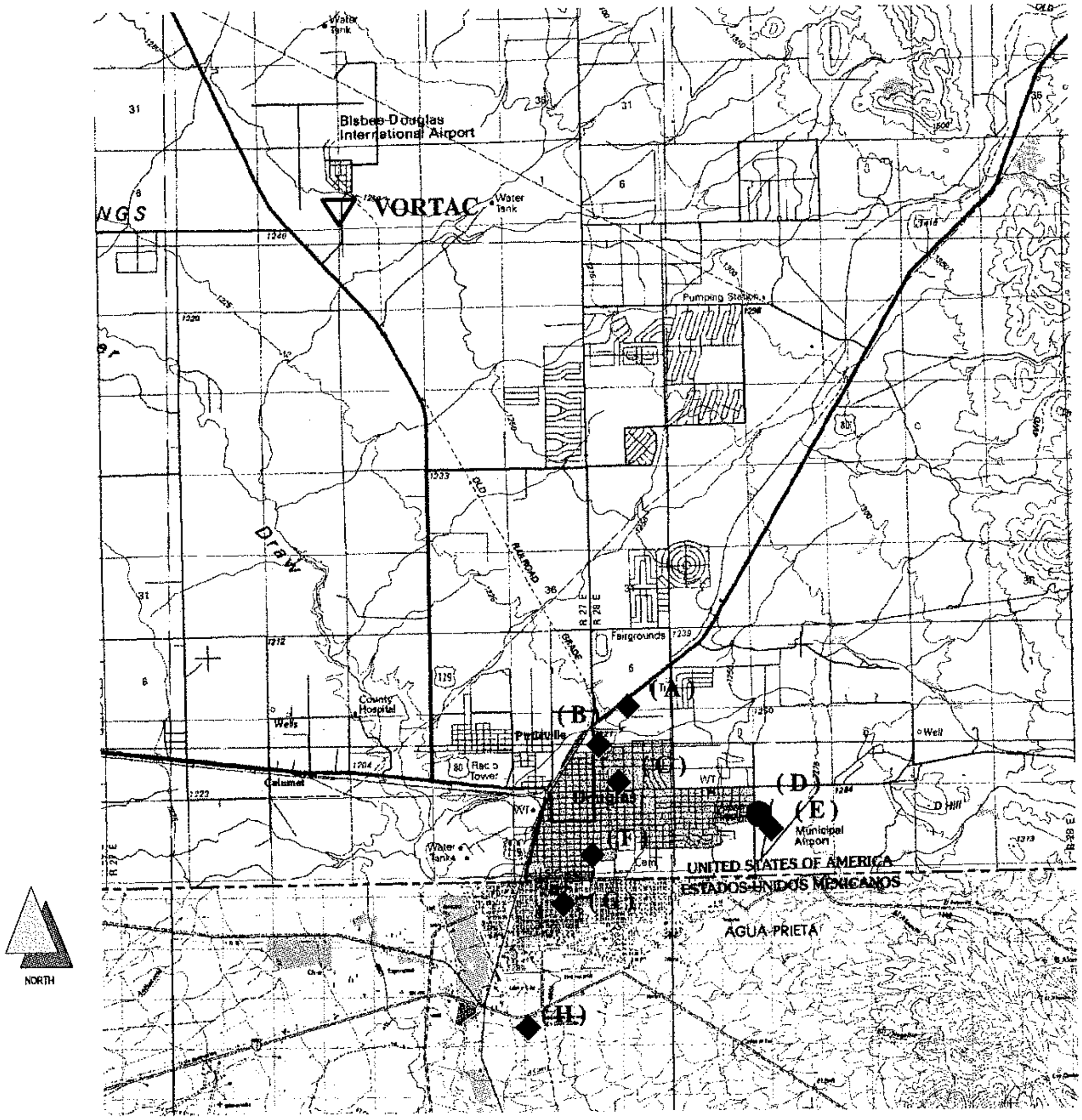
September 1999

Author: TS Summers

Map A-5 - Pima County DEQ Ambient Air Monitoring Sites

DOUGLAS/AGUA PRIETA BORDER STUDY AREA SITE MAP
APPROXIMATE LOCATIONS



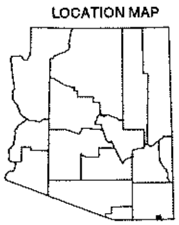
Air Quality Monitoring Sites

Background Sites

Camera/Meteorology Site

DOUGLAS/AGUA PRIETA SITES

A = Border Patrol Tower
B = ADOT Site
C = Red Cross SLAMS Site
D = Camera Site
E = Wind Profiler
F = Cemetery Site
G = Fire Station
H = CFE Site



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September 1999
Author: TS [illegible]

Map A-6 - Douglas/Agua Prieta Border Study Area Site